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A New *Thamnophis* from Western Chihuahua with Notes on Four Other Species

By WILMER W. TANNER

During the summers of 1956-1958 I secured a series of over 100 *Thamnophis* from the rugged mountains of western Chihuahua. Included are five species, one of which (*melanogaster*) is represented by a new subspecies. There is also a larger series of *T. elegans errans* than has been previously studied. All of these have been deposited in the Vertebrate Museum at Brigham Young University (BYU).

An equally large series from other museums has also been seen and studied. For these I am indebted to the following: Dr. Doris M. Cochran, U. S. National Museum (USNM); Dr. Norman Hartweg, Michigan Museum of Zoology (MMZ); Dr. E. R. Hall and Mr. John M. Legler, University of Kansas Natural History Museum (KU); Dr. Hobart M. Smith, University of Illinois Museum of Natural History (UI); Mr. Hymen Marx, Chicago Natural History Museum (CNHM); Mr. William H. Woodin, Arizona-Sonora Desert Museum (WHW and ASDM); Dr. Richard G. Zweifel, American Museum of Natural History (AMNH); and Mr. Wilbur G. Robison, who has been my field companion.

Thamnophis rufipunctatus Cope

In a recent study by Thompson (1957), this species is redescribed and diagnosed, thus no attempt will be made to set forth additional diagnostic characters. Certain clinal variations are indicated by the additional material.

In fifty-two from Chihuahua the ventrals range from 152 to 178, but these and the caudals average slightly less than for the series reported by Thompson. The average ventral-caudal totals actually indicate the differences between the Arizona and Chihuahua populations more clearly than if either character is used alone. In Chihuahua specimens, the ventral-caudals average 242.15, whereas in Arizona specimens the average is 254.5. In neither the ventrals nor caudals is there a latitudinal variation in the Mexican specimens. In approximately seven per cent from Chihuahua there are 23 rows near midbody and an occasional 19 rows before the vent, compared to the normal of 21-21-17.

The median internasal is not common in most specimens taken in the area between the main highway (Mexico 45) and the eastern base of the

Sierra Madre Occidental, but is rarely absent from highland specimens. Approximately half of the Arizona specimens have an azygous median internasal. As indicated by Lowe (1955) and Thompson, the Oak Creek segment of the Arizona population has a substantial increase of divided anals.

On the basis of a small series, with fifty per cent having a divided anal and spotted pattern, dorsal position of nostril and aquatic habits, Lowe concluded that *rufipunctatus* should be included in the genus *Natrix*. My examination of 24 Arizona and 50 Mexican specimens (some of which were included in the series studied by Lowe and Thompson) gives: 3 with anal divided, 1 grooved and 20 single for Arizona and all single from Mexico. The Provo, Utah population of *T. e. vagrans* with a divided anal (Tanner 1950) was a small population, which had been isolated in part by the growth of the city for the past fifty years. Although the Arizona population is not so restricted, it is nevertheless confined to a relatively small valley and there are few specimens (Arizonan or Mexican) outside of the valley that have a divided scute. Thus here, as in the case of *Thamnophis e. vagrans* at Provo, Utah, we are presumably dealing with a relatively small mutant population.

The habits of *rufipunctatus* are more aquatic than most other gartersnakes; however, upon a number of occasions *rufipunctatus* has been taken on rocky hillsides some distance from water (Chihuahua). We have always found *melanogaster* in or near streams, on rocks, or on overhanging willows. It, like *rufipunctatus,* has a long, rounded snout and may exhibit a distinctly spotted pattern.

In spite of the apparent similarities between the Oak Creek, Arizona population of *Thamnophis rufipunctatus* and *Natrix,* the retention of *rufipunctatus* in *Thamnophis* as presented by Thompson seems justified. The small Arizona population is the only population throughout its range, with such departures from the normal *Thamnophis* characters and since it is isolated and restricted, as in *elegans* at Provo, Utah, may represent, as suggested above, a small mutant population. The data available to me agrees with that presented by Thompson, and I am therefore retaining *rufipunctatus* in the genus *Thamnophis.*

Material: *Chihuahua*: Alamos, 70-74 Kilometers S Nueva Casas Grandes; Bavispe River, below Three Rivers, Chihuahua-Sonora Line; .5 mi. SW Bocoyna; 2 mi. N Chuhuichupa; Black Canyon, 8 mi. W Chuhuichupa; Rio Casas Grande; Chihuahua City; Colonia Juarez; Guadelupe y Calvo; Ahumada; 1½ mi. S. Cusarare; Meadow Valley; Mojarachic; Pacheco; San Pedro, on Papagochie River; Guerrero on Papagochie River; Progresso; and San Andres. *Durango*: Coyote; Guanacevi; and Rio Nazas, near La Garna.

Arizona: Coconino Co.: 18.5 mi. S. of Flagstaff; 20.5 mi. S of Flagstaff; Oak Creek near U. S. 89; Oak Creek 8 mi. N Sedona; 8.7 mi. N Sedona; 9.7 mi. N Sedona. Greenlee Co.: Black River, Diamond Rock Campground, SW Alpine. Yavapai Co.: Black Canyon; 7 mi. S Sedona; 23.7 mi. N Clarkdale.

Thamnophis eques megalops (Kennicott)

Two studies diagnose and summarize the general variations in this species. Ruthven (1908: 44-58) sets forth the clinal variations in specimens from Arizona to the state of Puebla, Mexico. Twenty-two were from

Chihuahua. Smith (1942: 115) examined specimens from the same general area, and recognized two subspecies (*m. macrostemma* and *m. megalops*). For the latter, 62 were examined from Chihuahua and five other Mexican states. A second study by Smith (1951) provides the present taxonomic status

In Chihuahua *e. megalops* is readily distinguished from all other gartersnakes by the lateral line on the third and fourth rows, rather than the second and/or third. In some localities it has been found with *rufipunctatus, cyrtopsis,* and *e. errans*; usually along streams where all commonly seek cover in water or heavy vegetation.

The variations in scale formulae are similar to those presented in previous studies, but with most averages higher than those previously reported. The Chihuahua populations are very stable in the number of rows. In only two specimens is there a variation from the 21-21-17 and these have 21-19-17. Supralabials are usually 8-8, a variation to seven or nine occurs in 8.6 per cent, with the fluctuation from the normal to seven or nine being approximately equal. Temporals show a greater variation; more commonly 1-2, but approximately 40 per cent have 1-3. Variation in the ventrals are presented in Table I.

The largest (a female) is 815 (measurements in mm.) in total length, tail 175, ratio of tail into total length .215. Males are seemingly smaller, the largest (672) has a ratio of tail into total length of .251.

Material: Areponapuchic; 2 mi. SW S. J. Babicora; Black Canyon, 8 mi. W Chuhuichupa; Bocoyna; 2 mi. N Old Casas Grandes; Chuhuichupa; 1 mi. S Chuhuichupa; 15 mi. S 6 mi. E Creel; Colonia Dublan; Colonia Garcia; Colonia Juarez; 10 mi. S. Parral; General Trias; 3 mi. S, 9 W La Junta; Jimenez, at Rio Florida; Madera; Minaca; 4.5 mi. S. Palomas; San Andres and San Pedro, on Papagochie River.

Thamnophis cyrtopsis cyrtopsis (Kennicott)

In the area under discussion, *cyrtopsis* is common, ranging throughout the western half of the state, from the desert valleys into the higher mountain valleys.

In the field *cyrtopsis* can be recognized by the paired black neck spots which are usually separated by the dorsal stripe, and the median stripe is usually expanded (3-5 rows wide) posterior to the spots. Only where *T. e. errans* occurs is there a chance for misidentification. The latter frequently has a similar color pattern on the nape, but differs in that the dorsal stripe is usually not expanded and the spots and stripes do not contrast so distinctly with the body color.

Variation in the rows is rare, only two of forty-six varied from the normal 19-19-17. Supralabials eight, with an occasional seven; infralabials ten, but with nine or eleven on occasion; postoculars vary approximately 17.5 per cent from the usual 3-3, with two or four scales occurring at about equal frequencies. The temporals are the most variable, usually 1-2; however, 1-3 occurred in 21 per cent of those studied.

The larger number of caudals, as indicated in Table I, suggests a proportionately longer tail. Although this is not true for all specimens, when compared with other species taken in Chihuahua, the averages are higher. The range of tail into total length is from .228-.296 (females

.228-.287, av. .252, males .233-.296, av. .260). Specimens with the greater number of caudals and also with the proportionately longest tails were taken 2 mi. N Cerocahui in SW Chihuahua.

Material: Areponapuchic; 2 mi. SW S. J. Babicora; 7 mi. S. Banderas; Bavispe River, near Chihuahua-Sonora line; Black Canyon, 8 mi. W. Chuhuichupa; 2 mi. N Cerocuhui; 4.5 mi. NE Colonia Juarez; 1.5 mi. S 6 E Creel; 23 mi. S 1.5 E Creel; Cuiteco; La Polvosa; Maguarichic; Mojarachic; 3 mi. S 10 E Pacheco; 6 mi. S. Parral; 2 mi. S 5 W San Francisco; 4 mi. S 1 W. Santa Thomas; 2 mi. W Samachuique; Tinaja Canyon, 22 mi. NW Colonia Juarez and 1.5 mi. S 2.5 E Umira.

TABLE I

Variations in the Ventral Scale Counts of *Thamnophis*

Race	Sex	Ventrals			Caudals			Totals
		No. Spec.	Range	Av.	No. Spec.	Range	Av.	
T. rufipunctatus	♂	41	155-178	164.96	37	73-89	79.70	
T. rufipunctatus	♀	29	152-167	159.7	24	64-76	69.16	
T. e. errans	♂	11	159-169	164.54	10	77-94	83.7	
T. e. errans	♀	11	157-162	158.73	10	69-81	73.3	
T. e. megalops	♂	24	165-177	170.82	19	76-96	85.9	
T. e. megalops	♀	34	153-171	162.59	19	65-83	75.1	
T. c. cyrtopsis	♂	27	164-182	174.0	22	83-110	95.0	
T. c. cyrtopsis	♀	19	156-177	170.9	17	71-104	85.7	

Thamnophis elegans errans Smith

Smith (1942: 112) described *errans* from six specimens, four taken at Colonia Garcia, Chihuahua and two from Coyotes, Durango; insufficient for a proper determination of relationships. However, on the basis of reduced rows and similar patterns, an implied relationship is made with *ordiniodes, atratus* and *hydrophila*. Also because of several resemblances to *eques,* (*cyrtopsis*), a possible relationship is suggested. Fitch (1948: 122), without additional material, concluded that *errans* with a reduced number of rows (19), ventrals (155-166), and maxillary teeth (17-18) was sufficiently distinct to be a species. His references to affinites also reflect doubts, but such relationships as may exist should (according to Fitch) be expected with the *elegans* (*ordinoides*) complex through *vagrans*.

This form has not been taken in larger numbers because it inhabits only the high mountain valleys of western Chihuahua and Durango. I have found it common at Colonia Chuhuichupa and it is perhaps not uncommon at Creel, Chihuahua.

The type locality, Colonia Garcia, is a small mountain valley at approximately 7500 feet.* Originally the lush meadows were surrounded by a heavy stand of Ponderoca and Black Jack Pine. A small eastward flowing stream drains the meadow and the Continental Divide is only a few miles to the west. There are several such valleys in this part of Chihuahua. Meadow Valley is approximately ten miles to the southwest and Chuhuichupa, a large valley in the head waters of the Bavispe River, is about thirty miles WSW of Garcia.

*See Goldman, E. A. 1951:120-4 for a more detailed statement on elevation and plant cover.

Within this general area *errans* is rather widely dispersed, at least during the rainy season of July and August. We have found it most common along streams and near ponds, or in or around logs or rock piles often some distance from permanent water. Their habits are surprisingly similar to *vagrans* in Utah and northern Arizona; and seemingly fill essentially the same ecological niche. Three other species (*rufipunctatus, e. megalops* and *cyrtopsis*) occur with *errans,* but around Chuhuichupa are rarely found far from water.

Some of the significant variations between 22 *elegans errans* and 146 *elegans vagrans* from Idaho and Utah are summarized in Table II.

TABLE II

Scale Rows	Per cent	Supralabials	Per cent	Infralabials	Per cent	Temporals	Per cent
			elegans errans				
21-21-17	21.43	7-7	57.14	9-9	3.57	1-2	52.17
19-21-17	25.00	7-8	17.86	9-10	7.14	1-2	30.43
19-19-17	53.57	8-8	25.00	10-10	75.00	1-3	
				10-11	14.29	1-3	8.70
						other	8.70
			elegans vagrans				
21-21-17	70.55	7-7	2.68	9-9	8.69	1-2	81.22
21-20-17	11.64	7-8	14.09	9-10	11.42	1-2	14.76
19-21-17	10.27	8-8 or more	82.55	10-10	72.42	1-3	
19-19-17	1.04			10-11	4.70	1-3	4.02
others	6.50	others	0.68	other	2.68		

In the Chuhuichupa series only nine have 19-19-17; seven have 19-21-17 and six have 21-21-17. If we assume that the number of rows near the middle are most significant, then 59 per cent of this series have 21 rows. By including the types (6 specimens all with 19-19-17 rows) then only 46.5 per cent have 21 near midbody.

Obviously, the Mexican series does have a reduction in the number of rows and supralabials; however, the frequent occurrence of 21 rows is significant and seemingly does establish a relationship between Chihuahua and Arizona populations of *elegans.*

The number of maxillary teeth in *errans* varies from 17 to 19. A small series of *vagrans* from the Little Colorado River drainage (Joseph City and Shummway) of Arizona, also range between 17 and 19. In *vagrans* from farther north in Idaho and Utah these teeth range from 16 to 21.

The color pattern is similar to *vagrans* but with these modifications: nape spots enlarged, more obvious and usually terminating the median stripe posterior to the parietals. The median stripe is distinct to the tail and not usually invaded or interrupted by small dark spots along its margins. In *vagrans* this stripe appears to undulate because of the irregular marginal invasions. Otherwise the patterns are similar.

Although there is no known intermediate population, the data available strongly suggest that *errans* is a disjunct subspecies of *elegans*, closely related to *vagrans* from which it seemingly arose.

Again we have a species whose present distribution suggests a past geological period with a more favorable climate thus accounting for its present distribution.

Material: Black Canyon, 8 mi W Chuhuichupa; Chuhuichupa; and 2 mi. S Creel.

Thamnophis melanogaster chihuahuaensis, n. subsp.

Type—BYU 14197, an adult male, from the Rio Bavispe, below Three Rivers and near the Chihuahua-Sonora line, by Wilmer W. Tanner and Wilber G. Robison, Jr., 29 June, 1958.

Paratypes—BYU 13371, 13373, 13451, 13493, 13496, 13505, 14198-202, 14208-10 topotypes: 14283, Cuiteco; KU 44275-78 1½ mi. E Creel; MMZ 111495-96, Mojarachic; 111497, Areponapuchic, Chihuahua, Mexico.

Diagnosis—Similar to *Thamnophis melanogaster canescens* but with caudals ranging from 68-84, rather than 49-75 as in *canescens*, average males 80.66, females 72.5; postoculars 2, 3, or 4. av. 3, usually 2-3 or 3-3; venter immaculate, rarely with spots, lateral lines faint but distinct; tail longer, in males one-fourth or more of total length, females two or three per cent less than males. Differs from all other Chihuahua *Thamnophis* by having cream-colored scales around vent.

Description of Type—Head narrow, gradually tapering to a rounded nostril; nostril clearly visible from above; internasals triangular and wedged between nasals to rostral; prefrontals large, extending laterally to form a broad contact with loreals, noticeably wider than long; frontal long, widest anteriorly; supraoculars long, slightly shorter than frontal and widest posteriorly; parietals large, much longer than wide, extending laterally to the second postocular; nasals large, divided below, but complete above; loreal quadrangular, longer than high; preoculars 2-3, upper one larger; eye moderate, its diameter equal to the distance to the naris; postoculars 2-3, lowest one largest; one large temporal, followed by two on the right side and three on left; supralabials 8-8, infralabials 9-9, fifth and sixth largest; mental small, triangular; first pair of infralabials in contact medially; two pairs of chinshields, second pair largest and separated by a pair of gulars.

Dorsals 19-19-17; all keeled; first row nearly smooth; ventrals 152; caudals 83; total length 560, tail 147; tail divided by total length, .262.

Dorsal surface dark grayish-brown, no dark spots, skin between lateral scales with small irregularly placed transverse light spots; lateral stripe faint but distinct, involving second row and edges of first and third; ventrals and caudals immaculate except for a few widely scattered spots; head colored like dorsum; anal cream colored.

Variation—In 18 specimens checked, three have the nasal and second labial in contact on both sides, five on one side, and in ten the nasal and second labial are separated. All have the nasal scale divided below the nostril and united above it; parts anterior and posterior to the nostril are subequal.

The preoculars vary as follows: one 1-1, eleven 2-2, five 2-3, four 3-3 and one 3-4; postoculars, two 2-2, five 2-3, ten 3-3, three 3-4 and one 4-4. Variation in the labials is slight, uppers usually 8-8, occasionally 8-9; lowers usually 10-10, occasionally 9-10, 10-11, or 11-11; little variation occurs in the dorsal rows; one has 20 at the middle, one sixteen and one nineteen before the vent; the rest have 19-19-17.

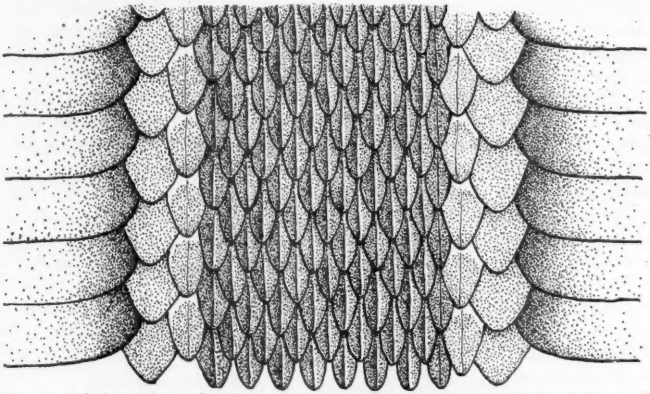

Fig. 1. Adult scale and color pattern. (BYU 14208 topotype-paratype.)

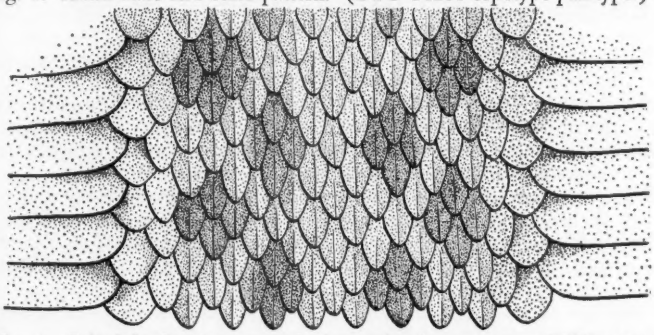

Fig. 2. Subadult showing spotted phase of color pattern. (BYU 14283, paratype from Cuiteco, Chihuahua.) Both *T. m. chihuahuaensis.*

Adults show little variation in color pattern. Juveniles and subadults are often spotted. One taken at Cuiteco was at first mistaken for the spotted *rufipunctatus.* Although in most the venter is immaculate, a few show scattered spots. A striking feature of the color pattern, and one which will serve to distinguish *m. chihuahuaensis* from all other *Thamnophis* in Chihuahua, is the cream colored scales around vent.

A female (BYU 13493) is the largest examined having a total length of 864, tail 214, which is 24.8 per cent of the total. The largest male (BYU 13373) is 639 in total length, tail 165 or 25.8 per cent of the total.

Range—Thamnophis melanogaster is known to occupy an area from the

Atlantic slopes in east Central Mexico, northwest to the Pacific slopes and north in the mountainous areas of Durango and Chihuahua. The known range for *T. m. chihuahuaensis* is western Chihuahua, extreme Sonora and northwestern Durango.

Relationships — Characteristics of the new subspecies *chihuahuaensis* strongly relate it to *canescens*. The scale and color patterns showing significant differences between these forms also indicate a clinal variation; most clearly seen in the ventrals, caudals, pre- and postoculars and in the ventral colorpattern. However, *chihuahuaensis* is similar to *melanogaster* in having an increased number of postoculars.

Data for six specimens from Durango are available, none has locality data. Five (USNM 23985-9) are associated with *m. canescens* because they have fewer ventrals and caudals, 141-147 and 53-61 respectively. A male (AMNH 4910) also labeled "Durango" is presumably from a more northern locality and has 153 ventrals and 78 caudals. On the basis of these it is assumed that the area of intergradation between *m. canescens* and *m. chihuahuaensis* occurs somewhere in the state of Durango.

A summary of the variations in the ventrals is presented in Table III.

TABLE III

Race	Sex	Ventrals			Caudals		
		No.	Range	Av.	No.	Range	Av.
T. m. canescens	♂	37	143-155	147.75	33	59-75	66.78
T. m. canescens	♀	44	137-147	142.23	38	49-63	56.56
T. m. chihuahuaensis	♂	13	146-156	151.58	13	75-84	80.66
T. m. chihuahuaensis	♀	10	143-149	145.2	8	68-76	72.5

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Notes on the Amphibians and Reptiles of Deschutes County, Oregon

By DONALD G. DUNLAP

The specimens and observations upon which this report is based* were collected in the western part of Deschutes County over a period extending from May of 1949 to September of 1955. The range of *Hypsiglena torquata* is extended 57 mi. S. of the nearest previously recorded locality. The following species appear to represent new county records: *Sceloporus occidentalis, S. graciosus, Uta stansburiana, Gerrhonotus coeruleus, G. multicarinatus, Charina bottae, Masticophis taeniatus,* and *Pituophis catenifer.*

Geologically, the region is characterized by an abundance of volcanic peaks, cinder cones and lava flows of various ages, some of them comparatively recent. Elevations range from 10,354 feet at the crest of the South Sister to about 2400 feet in the canyon of the Deschutes River in the northeastern part of the county. The crest of the Cascade Divide is above 5000 feet, except in the northern portion of the area where it descends to 4700 feet. In the south, thirty miles east of the Cascade Divide and separated from the main body of the Cascade Range by the valley of the Deschutes River, the Paulina Mountains rise to 7985 feet. Northward, the Central Oregon Plateau gradually descends toward the Columbia River.

Precipitation varies from about sixty inches annually near the summit of the Cascades to less than ten in the lower elevations. The growing season averages from eighty days or less in the higher elevations to more than one hundred thirty days in the lower areas.

(All measurements in millimeters.)

Ambystoma macrodactylum Baird

Long-toed salamanders were collected at Ryan's Ranch on the Deschutes River, 4050 ft. and at Kiwa Springs, 4779 ft., both in the yellow pine zone.

The Ryan's Ranch specimens, collected Aug. 28, 1949, were newly transformed, some still retaining short, unresorbed gill filaments. Five ranged from 93 to 102 total length. A single adult was found under a board in a dry, sandy area at Kiwa Springs Aug. 13, 1955, and many larvae, 15 total length, young of the year, were found in a slow flowing spring-fed pool. It is likely that the life history in this area involves a two-season larval life, as suggested for some larvae at Crater Lake, Oregon by Kezer and Farner (1955).

Taricha granulosa granulosa Skilton

No rough-skinned newts were found in Deschutes County, although many adults were observed in Scout Lake, 3650 ft., near the northern border of the county.

Bufo boreas boreas Baird and Girard

The boreal toad may be encountered throughout Central Oregon, below 6000-7000 ft., in areas with sufficient standing water to enable it

*Dr. Robert M. Storm of Oregon State College kindly supplied information on localities of a number of species, including *Phrynosoma douglassi, Gerrhonotus multicarinatus, Thamnophis elegans, Masticophis taeniatus* and *Hypsiglena torquata.*

to complete its life cycle. Toads were observed or collected from near timber line at Todd Lake and East Lake through the yellow pine forests along the Deschutes River to the sagebrush-juniper area at Alfalfa; Tumalo Falls, 5250 ft.; Todd Lake and Todd Lake Meadows, 6000-6100 ft.; Blow Lake, 5100 ft.; Senoj Lake, 5650 ft.; Elk Lake, 4890 ft.; along the Deschutes River between Benham and Dillon Falls, 4050 ft.; Deschutes Bridge, 4625 ft.; Snow Creek near Deschutes Bridge, 4600 ft.; west shore Paulina Lake, 6330 ft.; west shore East Lake, 6380 ft.; Alfalfa, 3360 ft.

Tadpoles were found in pools near the Deschutes River at Deschutes Bridge June 19, 1949. The water was 7° C. On July 8, 1949, tadpoles 20-23 in total length were found in small drying pools with water at 27° C. near the border of East Lake. On the same date, tadpoles 9-13 were observed at Lost Lake near East Lake in water of 16° C. A series of tadpoles collected at Todd Lake Aug. 26, 1955, range from 35 to 39 in total length and correspond to larval stages 35-38 (Limbaugh and Volpe, 1957).

Large numbers of small (20-30 snout-vent length) toads observed along the west shore of Paulina Lake July 3, 1952, and at Sparks Lake Aug. 21, 1957, were probably young of the year, although they were about twice the transformation size as listed by Wright and Wright (1949). Of twenty-three toads collected July 3, 1952 at Paulina Lake, five were in the 20-30 size group, two were immature at 38 and 42 and may have transformed the preceding year and fifteen were mature males ranging from 57 to 80 snout-length. These data are in harmony with the two-three year estimate given by Stebbins (1951) for the time required for *Bufo boreas* to attain sexual maturity. The largest female measured 102 snout-vent length.

Hyla regilla Baird and Girard

This is the most widely distributed amphibian in the area. Pacific tree toads were collected or observed at: Todd Lake and Todd Lake Meadows, 6000-6100 ft.; Blow Lake, 5100 ft.; Senoj Lake, 5650 ft.; Elk Lake, 4890 ft.; Kiwa Springs, 4779 ft.; Bend, 3600 ft.; on the Deschutes River at Lava Island, 4000 ft.; between Benham and Dillon Falls, 4050 ft.; and at Deschutes Bridge, 4625 ft., Big Lava Lake, 4740 ft.; East Lake, 6380 ft.; Lost Lake, 6400 ft.; Alfalfa, 3360 ft.

Adult *Hyla* were found in or near water with temperatures ranging from 5° C. at Todd Lake to 27° C. in small pools near East Lake. Males were calling at Senoj Lake on July 3, 1949.

Tadpoles ranging from 17-28 total length were found in East Lake July 8, 1949, in water at 17° C., and in shallow pools along the Deschutes River at Lava Island Aug. 30, 1955. Many of the larvae in the latter locality were undergoing transformation and there were numerous newly transformed tree toads in the area; others were found Aug. 28, 1949 and Aug. 30, 1955, along the Deschutes River between Benham and Dillon Falls.

Rana aurora cascadae Slater

The Cascade frog is abundant in the higher areas of the Cascade Mountains. It was collected in Deschutes County from Todd Lake and Todd Lake Meadows, 6000-6100 ft.; Tumalo Falls, 5250 ft.; Blow Lake, 5000 ft.; Elk Lake, 4890 ft.; little stream from Corral Swamp, 5050 ft.; Cultus Lake, 4700 ft.; Irish and Taylor Lakes, 5500 ft.; Lemish Lake,

5150 ft.

The frogs were found in or near water with temperatures from 6° to 16° C. and were usually first seen sitting on the bank of the pool or stream.

Tadpoles were found in Todd Lake Aug. 26, 1955. The tadpoles roughly corresponded to larval stages VII to XX (Rugh, 1951) with the majority corresponding to stage XIV, and with a total length range of 48-55.

Males exhibited swollen, darkened thumb pads at 47-48 snout-vent length, whereas some females had enlarged ovaries at 50-51. The largest of twenty-one adult males collected in Deschutes County measured 57; the largest of twenty-one females measured 71. The largest male examined was collected at Jorn Lake in Linn County and measured 58, whereas the largest female, from Irish Camp Lake, Lane County, measured 78.

Rana pretiosa pretiosa Baird and Girard

All adults had bright salmon-red markings on the lower surfaces of the legs and sides, in sharp contrast to the light orange underparts of specimens found to the east in the Mill Creek and Mark Creek area of Crook County. Consequently, these brightly colored frogs of the east slope of the Cascades are tentatively referred to the subspecies *R. p. pretiosa* (Dunlap, 1955).

Specimens of *Rana pretiosa* were found in the following localities in Deschutes County: northwestern side of Mud Lake, 4800 ft.; Big Lava Lake, 4740 ft.; along the Deschutes River between Benham and Dillon Falls, 4050 ft.; Cultus Lake in and near source of Cultus Creek, 4700 ft.; ford over Cultus Creek, 4500 ft.; Little Cultus Lake at source of Deer Creek, 4750 ft.; Snow Creek near confluence with Deschutes River, 4500 ft.; Little Deschutes River, 4180 ft. and 4220 ft.; small stream between Lapine and the Little Deschutes River, 4230 ft.; small stream emptying into Wickiup Reservoir, 4400 ft.; west shore of Paulina Lake, 6330 ft.

Specimens were collected in or near water with temperatures from 10° to 20° C. Only immature frogs were found near the water with 10° C. temperature and these were sitting on the creek banks and seemed reluctant to enter the water. More typically, frogs were seen floating in shallow, still water.

Mature tadpoles with well developed hind legs were observed in shallow water with an abundance of emergent sedges and rushes on the edge of Big Lava Lake Aug. 13, 1950. Recently transformed frogs found on the Deschutes River between Benham and Dillon Falls Aug. 30, 1955, measured 24-25 long.

Males exhibited swollen, darkened thumb pads at 48-49 snout-vent length, whereas some females had enlarged ovaries at 50-52. The largest specimen of a group of twenty-eight adult males collected in the area measured 68; the largest female in a group of thirty-five was 85.

The western spotted frog is usually found lower on the eastern flank of the Cascades than is the Cascade frog. In the region investigated, the line of contact between the two forms is abrupt. For example, Mud Lake and Elk Lake are about one-half mile apart, yet only *R. aurora cascadae* was found at Elk Lake, and only *R. pretiosa* at Mud Lake. Some overlap of range was found at Cultus Lake. In areas where the two species are

apparently not in contact, *R. aurora cascadae* extends lower, e.g., to 2900 ft. at Jack Creek (Jefferson County), and *R. pretiosa* higher, e.g., 6330 ft. at Paulina Lake, than is the case where the two species occupy adjacent areas.

Sceloporus occidentalis Baird and Girard

Western fence lizards were found: 2.7 mi. N. of U. S. Highway 28 on Lower Bridge Road, 2980 ft.; 5 mi. E. and 4 mi. N. of Deschutes Co. Courthouse, 3380 ft.; 3 mi. N. and 4 mi. W. of Deschutes Co. Courthouse, 3650 ft.; 3.5 mi. S. and 2.5 mi. W. of Deschutes Co. Courthouse, 3800 ft.; Alfalfa, 3360 ft.

All were collected in the yellow pine or western juniper-sagebrush areas, where rock outcrops were abundant. A sample of five specimens had single gular patches and dorsal scale counts of less than 45 rows. They best fit the *S. o. biseriatus* diagnosis of Stebbins (1954), and the *S. o. longipes,* diagnosis of Bell (1954).

Sceloporus graciosus Baird and Girard

Sagebrush lizards were found: 5 mi. E. and 4 mi. N. of Deschutes Co. Courthouse, 3380 ft.; 3.5 mi. E. and 1 mi. N. of Deschutes Co. Courthouse, 3600 ft.; 3.5 mi. S. and 2.5 mi. E. of Deschutes Co. Courthouse, 3700 ft.; Alfalfa, 3360 ft. All were collected in the western juniper zone or in areas with a mixture of yellow pine and western juniper.

Four specimens with snout-vent lengths from 46-51 had dorsal scale counts of 53, 54, 54, 58; av., 55. This scale count is somewhat higher than that for *S. g. graciosus,* which is given as 42-53 by Stebbins (1954) and lies within the scale count range of *S. g. gracilis,* which is characterized as having 52-68; av., 61.

Uta stansburiana stansburiana Baird and Girard

Specimens were found in the hot, dry canyon of the Deschutes River near the northern edge of Deschutes County at Lower Bridge, 2530 ft.; and at Cline Falls, 2840 ft.

Phrynosoma douglassi Bell

Horned lizards were found along the road from U. S. Highway 20 to Big Lake; near the top of Cache Mountain, 5570 ft.; and at Black Butte, all in or near the NW. corner of Deschutes County.

Gerrhonotus coeruleus principis Baird and Girard

One northern alligator lizard was collected from under a rock in the grass near the shore of Big Lava Lake, 4740 ft.

Gerrhonotus multicarinatus scincicauda Skilton

Oregon alligator lizards were found along the Deschutes River at Lower Bridge, 2530 ft.

Eumeces skiltonianus Baird and Girard

Western skinks were found near the Deschutes River between Benham and Dillon Falls, 4050 ft.; Bend, 3650 ft.; Cline Falls on the Deschutes River, 2840 ft.; and Lower Bridge, 2530 ft. The first two localities are in the yellow pine zone, the latter two in the juniper-sagebrush zone.

Charina bottae utahensis VanDenburgh

Rubber boas were collected in the yellow pine zone, or in the yellow

pine-juniper ecotone: 3.5 mi. S., 2.5 mi. E. of Deschutes Co. Courthouse, 3700 ft.; Bend, 3650 ft.; 3 mi. S., 2.5 mi. W. of Deschutes Co. Courthouse, 3800 ft.; 1.5 mi. S., 1 mi. W. of Deschutes Co. Courthouse, 3700 ft. All were taken from within rotted logs or under objects on the ground.

Thamnophis elegans vagrans Baird and Girard

The wandering garter snake was found at Lower Bridge on the Deschutes River, 2530 ft.

Thamnophis sirtalis fitchi Fox

Fitch's garter snake is commonly encountered in marshy areas in the spruce-fir and yellow pine zones. In certain localities, it is extremely abundant. Specimens were found at: Elk Lake, 4890 ft.; along the Deschutes River between Benham and Dillon Falls, 4050 ft.; Big Lava Lake, 4740 ft.; Deschutes Bridge, 4625 ft.; Snow Creek, 4500 ft.; East Lake, 6380 ft.

Masticophis taeniatus taeniatus Hallowell

One striped whip snake was collected at Cline Falls, 2840 ft., and one at Lower Bridge, 2530 ft.

Pituophis catenifer deserticola Stejneger

Gopher snakes were found 3 mi. N. of the Deschutes Co. Courthouse, 3470 ft., in mixed yellow pine and juniper woodland; and at Lower Bridge, 2530 ft., in the juniper-sagebrush zone.

Hypsiglena torquata Gunther

Eight night snakes were collected at Lower Bridge, 2530 ft.

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DEPT. ZOOL., STATE UNIVERSITY OF SOUTH DAKOTA, VERMILLION

The Status of Gerrhonotus in Utah

By WILMER W. TANNER

In 1945, *Gerrhonotus coeruleus utahensis* Woodbury was described from a single specimen, presumably taken at Sink Valley, Kane County, Utah. The type locality is located in a small valley approximately five miles south of Alton, and is in the Kanab Creek drainage. The valley floor is covered by some meadows in the vicinity of springs, but with much sage brush between the moist areas. Along the edge of the valley and on the slopes are clumps of Oak, and a few scattered Junipers.

Since the description appeared, there have been many attempts by herpetologists to secure additional specimens. All have met with failure. During the past twenty years, collecting trips, led by various staff members at the Brigham Young University Zoology Department have worked in Kane and Washington Counties without finding additional *Gerrhonotus,* although other herpetological species known to occur in these counties have been taken in moderate numbers. This has led to some doubts as to whether a native population of alligator lizards actually occurs in Utah. Two points seem obvious: First, such a large lizard should not be difficult to find in the limited cover in Sink Valley. Second, if such a lizard occurs in Utah, it should be widespread throughout the many similar valleys of southern Utah.

In order to familiarize myself with the general characteristics of the habitat used by *coeruleus*, I have taken every opportunity to secure it in California and Oregon. In the coastal areas, there is considerably more annual rainfall, greater humidity, and more vegetative cover than in southern Utah. Although type of habitat seemingly is significant for *coeruleus* inasmuch as this species does live in the more humid areas, there are, however, other members of the genus which do live in rather dry habitats. Assuming that such an adaptation may occur in *coeruleus* (in spite of the fact that it has not extended its range into such habitats in southern California) then our understanding of the Utah Alligator lizard must be based primarily on morphology.

A careful analysis of the diagnosis and description set forth in the original description (Woodbury, Proc, Biol. Soc. Wash. 58:5-10, 1945) indicates that there are at least ten characteristics which may be used to distinguish the Utah alligator lizard from *shastensis* and *palmeri,* two forms occurring in northeastern and east central California:

1. All sixteen rows of dorsals well keeled.
2. Frontoparietals in contact medially.
3. Supranasals form a pair behind the rostral.
4. Nasal narrowly in contact with rostral.
5. Forty-five dorsal transverse scale rows, (from occipit to base of tail).
6. Fifty-seven transverse ventral rows between mental and anal scutes.
7. Lighter in color and with dark spots reduced in size.
8. Little difference between color of head and body.
9. Dark color of abdomen mostly along edges of both transverse and longitudinal rows, but with some diffusion of pigment at center of many scales.

10. White spots on tips of dark scales inconspicuous or missing.

Although specimens of both *shastensis* and *palmeri* were used in the preparation of the original study, there is, unfortunately, no statistical comparisons nor data indicating the size of the comparative series or from which part of their range the specimens were taken.

In order to be more certain of the relationships, a series of *shastensis* from Shatsa County, and a series of *palmeri* from east central California have been compared with the original description and the type of *utahensis* (UU 1676)*.

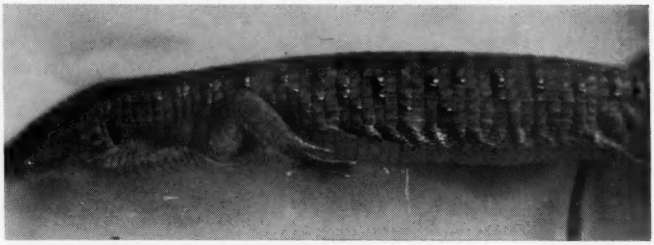

Fig. 1. *Gerrhonotus c. shastensis* Fitch. MVZ 24122. Sacramento River, mouth of Castle Creek, Shasta Co., Cal.

In order that details, where pertinent, may be included each point is considered separately and in the order listed above;

1. All three forms have sixteen rows of dorsals and each row is equally well keeled.
2. In *shastensis* the frontoparietals may or may not be in contact medially. This characteristic is variable, some specimens having as wide a contact (MVZ 24122, 43543) as in the type of *utahensis* and grading to those which are widely separated. I did not see a *palmeri* in which these scales were in contact, although several were narrowly separated.

3. and 4. No noticeable difference.

5. In *shastensis* the dorsals range from 42 to 49, with an average of 46.8; in *palmeri*, from 43 to 50, average 44.4. The 45 dorsals occurring in the type of *utahensis* is within the range of variation of each of the compared subspecies.
6. The ventrals range from 56 to 62, and average 60.5 in *shastensis*. Again the 57 for *utahensis* is within the range for *shastensis*. In *palmeri* the ventrals range from 38 to 42.
7. A comparison of Fig. 1, with that of Fig. 1, *utahensis* type specimen, Woodbury (*loc. cit.*), indicates that there are in *shastensis* individuals with equally reduced and light color patterns. Al-

*I wish to thank Mr. James D. Anderson of the Museum of Vertebrate Zoology at Berkeley, California, for the loan of: *G. c. shastensis* 10106-7, 15046, 15048, 15049-50, 16282, 241222-3, 41254-5, 43543, 44687, 66181, 66183, 6703-6, Shasta County, *G. c. palmeri*-43102 and 43104 Calaveras County; 7204, Eldorado County; 5834-7, 5918-21, 7190-3, 41191 Mariposa County; 33861, 56854 and 66182 Plumas County; 60795, 62173-4, and 66314-5 Tuolumne County.

I am indebted to Dr. Jack Twente, University of Utah, for permission to examine the type of *utahensis*.

though figures for *palmeri* are not presented, individuals with a reduced pattern also occur (MVZ 40667).

8. and 9. No noticeable difference.

10. A general comparison of the figures listed above, as well as specimens, suggests that there is a real difference. However, a careful examination of the type of *utahensis* reveals that many scales (but less when compared with most *shastensis*) have clear spots near the tips. These have seemingly been stained by preservatives so that they do not stand out as white spots, but are now similar in color to the general body color. Under magnification these small unpigmented spots are clearly discernable.

In view of the similarity in both color pattern and scalation, I believe that *Gerrhonotus coeruleus utahensis* Woodbury is conspecific with *Gerrhonotus coeruleus shastensis* Fitch, and that the name *utahensis* belongs in the synonomy of the latter subspecies.

The question of how a *Gerrhonotus* was collected in Utah is still not explained, nor is it possible to provide a final answer. The following explanation seems plausible to me; and since there apparently is no other, I offer it for what it is worth.

On August 6, 1959, a letter from Mr. Harold T. Pinkett, Archivist in Charge, Agricultural and General Services Branch, Natural Resources Records Division, at the National Archives, Washington, D.C. states that: "The Secretary of War approved on May 26, 1933 the establishment of 14 emergency camps of 200 men each on State owned land in Utah. One of these camps was established at Alton, Kane County, Utah on June 16, 1933 and was maintained until about Nov. 15, 1933."

Many of the CCC boys were pet hobbyists and retained various kinds of lizards, (the horned lizard being a great favorite) small mammals, etc., for many months. According to Dr. Lloyd Whitlock, a recerational director of one of the Utah-Nevada CCC Districts, the boys were permitted to retain such pets as they transferred from camp to camp.

It is my belief that the specimen which was collected in August 1933 and described as *G. c. utahensis* Woodbury in March 1945 was actually transported to Utah as an oddity or pet and later became a specimen in the University of Utah collection.

There is really no way of knowing where it was originally taken or by whom. Unfortunately its collector is not listed in the original study.

DEPARTMENT OF ZOOLOGY, BRIGHAM YOUNG UNIVERSITY, PROVO, UTAH

A RECORD SIZE HORNED TOAD.—On August 12, 1959, the author received five specimens of *Phrynosoma cornutum* from Gerald Keown in Texas. One adult male exceeds the previous known record (Conant—1959—Field Guide to Reptiles and Amphibians) by exactly one inch. The lizard measures 6⅛ inches.—*Steve Christman, Barneveld, New York.*

A Method for Detecting Copulated Female Snakes

By HAJIME FUKADA

It is very painstaking to try to locate mating snakes in the field and you succeed only by chance. In the field study of snakes, the writer has been applying the following method to detect the copulated females in *Natrix tigrina tigrina* (Boie). Further study showed that this simple method is applicable to other species also.

Hold the female snake at the neck with the left hand; press the ventral surface immediately anterior to cloaca with right thumb and squeeze off the mucous fluid of cloaca or vagina; smear a slide glass with the fluid and examine it under a microscope. If the female had been copulated prior to the test, there would be many active spermatozoa in the preparation. This method of examining for spermatozoa can be applied as late as one, two, or more weeks after copulation in the fall in *tigrina*. Just after copulation, abundant spermatozoa are seen; but in time, the amount of spermatozoa found becomes less abundant. In males this method is applicable, but spermatozoa are rather difficult to see. Mucus obtained by scraping around everted hemipenes, or fluid obtained from the cloaca is used, but the latter brings good results in general. In males, these data may indicate the season in which the species mate.

The following are some results obtained:

Natrix t. tigrina. This species usually mates in the fall, and almost all adult females caught in November contain spermatozoa in their vaginae, as shown in Table 1. The first female that had spermatozoa in her vagina was caught October 14, 1957 and October 17, 1958. In the spring of 1959, the writer examined all adult snakes and found that one female (No. 277?, April 22) contained active spermatozoa in her cloaca; whereas males were found containing spermatozoa in their cloacal region on May 25, June 17, and 27 (total number of snakes examined was 31 females and 19 males from April through June, (Table 2, the first two lines). A Spring mating was observed on June 13, 1959, in captivity.

Table 1. Existence of spermatozoa in vaginae of female *Natrix tigrina tigrina* in the fall (1957 and 1958).

Date	Snakes examined	Snakes with spermatozoa
11 - 20, Oct.	7	3
21 - 31, Oct.	13	8
1 - 10, Nov.	10	9
11 - 20, Nov.	10	9
21 - 30, Nov.	0	0

Elaphe quadrivirgata (Boie), *Elaphe climacophora* (Boie), and *Elaphe conspicillata* (Boie) mate in the spring or in early summer. Table 2 shows results of cloacal test for spermatozoa in 1959. From the study of this table it is clear that the cloacal test is useful to detect the mating season of these species also. In the spring, spermatozoa are rather hard to detect from vaginae even in the presumed case of mating. In the fall, on the contrary, spermatozoa are very easily detected by this method as in the case of female *tigrina*. This may be caused partially by the fact that spermatozoa remain in the cloaca considerably longer in the fall than in the spring.

Table 2. Result of cloacal test for spermatozoa. Number of snakes containing spermatozoa (numerators) and number of snakes examined (denominators) are shown in ten-day periods, 1959.

		April		May			June		
		11-20	21-30	1-10	11-20	21-31	1-10	11-20	21-30
N. t. tigrina	female	0/2	1/8	0/2	0/6	—	0/1	0/2	—
	male	0/1	0/9	—	0/3	1/2	—	1/2	2/2
E. quadrivirgata	female	0/2	1/11	0/3	0/3	1/3	—	—	—
	male	0/1	0/13	0/2	0/3	0/1	—	1/2	—
E. climacophora	female	—	0/2	—	0/2	—	—	1/2	—
	male	—	—	—	0/2	—	—	1/2	—
E. conspicillata	female	1/1	—	0/1	1/1	—	—	—	—
	male	1/1	—	—	1/1	—	1/1	—	—

The cloacal test for spermatozoa is useful to prove copulation in captivity. After a male is introduced into a cage of females, effective mating can be proved by the cloacal test even when actual copulation is not observed. The writer has always used this method in such cases.

Reference. Fukada, H. 1959. Biological Studies on the Snakes. VI. Growth and Maturity of *Natrix tigrina tigrina* (Boie). Bull. Kyoto Gakugei Univ., Ser. B, No. 15. (in press)

ZOOLOGICAL LABORATORY, KYOTO GAKUGEI
UNIVERSITY, FISHIMIKU, KYOTO, JAPAN

NOTES ON *TRIMERESURUS F. FLAVOVIRIDIS*.—During the last week of May, 1959 the Baltimore Zoo received two fine specimens of the "habu" (*Trimeresurus f. flavoviridis*) which were flown in from Okinawa. Each snake is several inches in excess of five feet.

They have been kept in a large glass-fronted exhibition cage since their arrival where they spend most of their time draped along a water pipe about four feet above the floor, to which they rarely descend.

Both are erratic feeders. After four months in captivity, one has eaten only a small mouse, the other several birds. Cavies, rats, mice, birds and lizards have been offered regularly at one week intervals.

One deposited an egg on July 27, five more on August 13 and another on August 14. Three were soft and flabby and apparently infertile; the four others, though somewhat soft-shelled, were firm and well-shaped. All were placed in an incubating jar floored with damp paper towels.

Near the end of August, all of the eggs developed areas on the shells through which the liquid contents of the eggs escaped. After several days they all collapsed.—*Frank Groves, Baltimore Zoo.*

Observations on Various Stages of Topotypic *Plethodon jordani jordani*

By ALBERT E. REYNOLDS

Though it is now nearly six decades since the red-cheeked *Plethodon* of the Great Smoky Mountains was recognized and given taxonomic status by Blatchley (1901), this population of large *Plethodons* has not, during the intervening years, been the subject of numerous published reports. Such works as Dunn's (1926) monograph and Bishop's (1947) handbook have dealt with adult characteristics, but there still exists a shortage of information on the younger stages. The most significant contribution to knowledge of the younger stages of *Plethodon jordani jordani* (Hairston, 1950) has been Wood's (1947) report on a series of 29 specimens the largest of which was 28.9 mm in total length. This paper is offered as a complement to Wood's report since the smallest specimen reported on herein was 32.9 mm in total length, and the series of specimens as a whole includes stages up to and including adulthood.

The opportunity to make this study of *Plethodon jordani jordani* resulted from collecting which was a part of a broader program aided by a National Science Foundation grant-in-aid, grant administered by the Highlands Biological Station, Highlands, North Carolina, at which Station the program was based. The author makes grateful acknowledgement to Miss Thelma Howell, Executive Director of the Highlands Biological Station, for helpful counsel and guidance, and to Mr. Arthur Stupka, Park Naturalist, Great Smoky Mountain National Park, for advice and cooperation.

The specimens discussed herein were collected at Indian Gap in the Great Smoky Mountains, on the Tennessee side, hence all specimens are topotypes from Sevier County, Tennessee. On August 27, 1957, thirty-one specimens were obtained, mostly from beneath flat rocks that were strewn about the forest floor in the midst of a thick carpet of fallen needles; a few, however, were obtained from beneath pieces of wood. The site was in spruce-fir forest, and while the ground was sloping, the approximate altitude was 5,100 feet. The collecting was completely non-selective, yet early in the foray it became apparent that an unusual opportunity was being afforded for the taking of younger stages. Of the 31 animals taken, 23 proved to be young.

The animals were examined individually both macroscopically and under binocular magnification for general appearance, color, and markings, while either freshly dead or alive under chloretone anesthesia. Measurements and other quantitative studies were completed shortly after fixation in 5% formalin. Micrometer calipers were used in measuring, some of the smaller distances being first determined by using the fine points of drafting dividers. In what follows, the term "head" will refer to length from the tip of the snout to the gular fold, the term "trunk" will refer to length from the gular fold to the anterior angle of the vent, and the term "tail" will encompass whatever length occurs posterior to the anterior angle of the vent. The term "chin" will be used to indicate the ventral surface from the tip of the snout to the gular fold, and the term "belly" will designate the venter from gular fold to the anterior

angle of the vent. Since eight of the 31 animals had incomplete tails, the snout-to-vent (S-V) measure was adopted as the basic measurement for comparative purposes. The histogram of Figure 1 illustrates the bimodal distribution of the 31 specimens when classified on the basis of S-V length. The eight larger animals plotted on the right of Figure 1 proved to be adults, five females and three males. These adults conformed to the usual descriptions (cf. Dunn, 1926; Bishop, 1947). Vomerine teeth varied from 7 to 10 in number; one specimen had 14 costal grooves, five had 15, and two had 16; all were bilaterally symmetrical for this character. Other characteristics of these adults will come under discussion below.

SIZE AND PROPORTIONS

Reference to the adult columns of Part A of Table 1 will show that the adult salamanders of this series were in no case as great in total length as Blatchley's (1901) type (124 mm), or the adult male (129 mm) described by Dunn (1926), or Bishop's (1947) specimen of 135 mm, or the 149 mm given as maximal total length by King (1937). As a whole this group of eight adults conformed much better to the series of ten animals mentioned by Bishop, which averaged 112.5 mm in total length. Dunn (1926) referred to the tail as "longer than head and body," and Bishop (1947) mentioned it as "averaging about 50 per cent. of the total length"; in Table 1 the left-hand columns of Items 3, 5 and 10 show that the eight adults of this series stand in essential verification of these relationships. In Blatchley's type specimen, the trunk/head length ratio had a value of 3.8, but in these eight adults the heads (Item 12, Table 1) were apparently relatively longer, since the mean ratio was 3.30, a value which compares favorably with the value of 3 1/3 reported by Dunn (1926). Item 11 of Table 1, a head length/width ratio, was used by Blatchley (1901) in the original description of *jordani* in the type form of which the ratio was 1.3. Since the minimal value of this ratio in the present series was 1.36, and the mean value 1.41, it would appear that these eight adults possessed more slender heads than did the type specimen.

For the 23 young salamanders in this series, the right side of Table 1 gives information which parallels that given for adults, and reference thereto will show that the smallest animal was somewhat longer than the 28.9 mm total length of the largest juvenile described by Wood (1947). Wood's series was a remarkably homogenous one, all 29 specimens falling within a 6.4 mm range (22.5 to 28.9 mm) whereas the series described herein exhibited a greater range wherein the largest young was about twice the length of the smallest, and the largest young specimen approached adult size. Bishop's (1947) smallest specimen was 29.0 mm in total length but had an incomplete tail, Bailey (1937) observed two specimens with respective S-V lengths of 22.3 and 24.0 mm, and King (1939) mentioned having seen specimens of 30 and 40 mm total length in April and May. Apparently the only observed specimen as small as those studied by Wood was a 28.0 mm specimen mentioned by Dunn (1926).

When the entire series of 31 animals was listed in serial and sequential order by S-V length, the smallest and presumably the youngest was

18.3 mm in S-V length, 32.9 mm in total length. The second animal in sequence was larger by 3.4 mm in S-V length, by 6.6 mm in total length; this second animal was also the first of 20 in the sequential series which varied in a quite continuous manner from 21.7 to 26.2 in S-V length, and from 39.5 to 46.8 mm in total length. As one passed from animal to animal in this sequence of 20 specimens, S-V length differences were less than 1.0 mm, and total length differences were 4.0 mm in two cases, less than 2.0 mm in the remaining 18 cases.

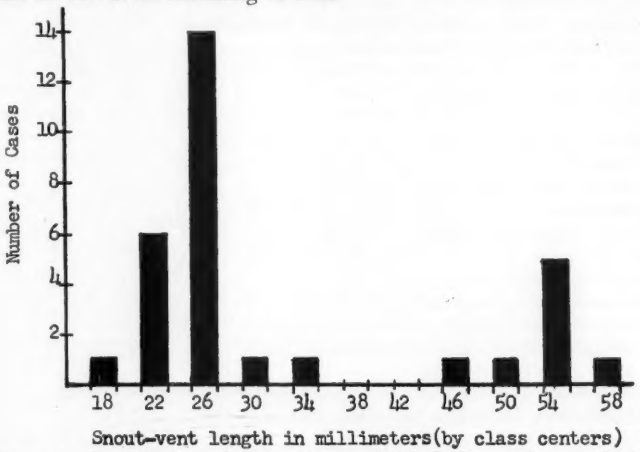

Figure 1. Distribution of 31 specimens of *Plethodon jordani jordani* by snout-vent length. Class limits of the first two classes were respectively 16.0 to 19.9 mm and 20.0 to 23.9 mm, other class limits in accordance therewith.

The largest of these 20 animals was exceeded by the next and 22nd in serial sequence by 3.9 mm in S-V length and 13.0 mm in total length; this 22nd animal was in turn exceeded by the 23rd and last of the young specimens to the extent of 5.5 mm in S-V length and 6.3 in total length. In review, the 23 juveniles of this series exhibited quite continuous length variation except at the extremes of the distribution; the smallest and two largest evinced the greatest discontinuity of length variation. Even greater discontinuity, about twice that seen elsewhere in the distribution, occurred between the largest young specimen and the smallest adult in the whole series of 31 salamanders; this relationship is graphically portrayed in the bimodality of the histogram of Figure 1. Among themselves, the adults differed by less than 1.0 mm in S-V length and less than 3.0 mm in total length. In connection with length difference between young and adults, King (1939) observed 67 specimens of *P. j. jordani* and found that they fell into one group varying between 43 and 63 mm in total length, and a second group varying between 80 and 149 mm in total length. King postulated that the smaller animals represented salamanders in the second year of life, that the larger group was made up of animals in the third and subsequent years, and that adulthood and sexual maturity was attained

during the third summer at about 80 mm of total length. In King's series the major length discontinuity, and that which separated the juvenile from the adult condition, was of 17.0 mm magnitude between 63 mm and 80 mm of total length. The series of 31 specimens reported on herein exhibited its major discontinuity of 25.9 mm magnitude between 66.9 mm and 92.8 mm of total length (35.6 mm and 46.0 mm in S-V length); this series thus provided, in essence, verification of King's distinction between the juvenile and adult states in terms of length.

Certain other indicated differences produced by the processes of growth and development to adulthood may be seen by comparative examination of the right and left columns of Table 1 for certain items. For example, mean values given for Item 10 would indicate that the tail constituted a greater proportion of total body length in the adult state than it did in juveniles. Heads in the young appeared to be relatively wider than heads of adults (Item 11). Item 13, trunk length divided by maximal trunk width, may be considered to be either a "stockiness index" or a "slenderness index," and the values in the table would indicate that adults of *P. j. jordani* were relatively more slender, juveniles more stocky, at trunk levels. As to head width, Blatchley (1901) commented "head distinctly wider than body"; this distinctness, in the eight adults of this series, amounted to a mean difference of 1.46 mm between neck width and posterior head width, a difference which was 21% of neck width. In the young specimens this distinctness was accentuated, the mean difference being 36.5% of neck width. Comparative study of Items 6, 7, 8, and 9 in Table 1 would tend to indicate that heads were relatively longer and trunks relatively shorter in the young than in adults.

This latter head vs. trunk length relationship prompted the devotion of special attention to the serial arrangement wherein all 31 animals were listed in sequential order from smallest to largest by S-V length. While it may be belaboring the obvious to state that when an animal grows, it grows all over, inspection of the quantitative values in the serial arrangement made it indeed apparent that both head and trunk increase in actual length as S-V length increased. But when attention was focused, not on actual size, but on proportion, a different pattern emerged. The smallest animal had a head that was 0.29 of S-V measure while the largest animal had a head that was only 0.22 of S-V length, in spite of the fact that the latter head was about twice the actual size of the former. Conversely, trunk length of the smallest salamander was 0.71 of S-V length, while that of the largest was 0.78. Passing from animal to animal in the sequential series of 31 animals, increments of S-V length were accompanied in nearly perfect order by decreasing head proportions and increasing trunk proportions. These data afforded ample evidence that in *P. j. jordani* the head and trunk grew at differential rates, the head more slowly, the trunk more rapidly. As compared with general S-V length increase, each region thus constituted an instance of allometric or heterogonic growth. The allometry equation of the general form $Y = bX^k$ was rendered into the logarithmic forms

(1) $\log Y_h = \log b + k \log X$ (for the head), and
(2) $\log Y_t = \log b + k \log X$ (for the trunk), where

Y_h=head length, Y_t=trunk length, X=S-V length, and b and k are

constants to be calculated from the data. The quantitative data for each body region were then analyzed and subjected to treatment by the method of least squares (Simpson and Roe, 1939, Chap. XVI). Reconverted to the general form, the resulting equation for head length (1) became $Y_h = 0.49X^{0.82}$ while that for trunk length (2) became $Y_t = 0.61X^{1.06}$. With respect to head length (1) the value of the exponent, the constant k, was less than 1.0 indicating negative allometry while the fact that the same constant was greater than 1.0 indicated that trunk length (2) was positively allometric. The calculated values of $k = 0.82$ and $k = 1.06$ provided numerical expressions of the fact that, respectively, the head length increased relatively less, the trunk length increased relatively more, with each increment in snout-vent length (X in the equations).

COLOR AND MARKINGS

In these *P. j. jordani* the general or ground-color of the dorsum was black, but in the young this was lighter than the intense blue-black of the adults. Ventral surface ground-color was characterized in the adults by differences of melanophore concentration such that chins were light gray, bellies medium gray, and tails dark gray to black; within each body level, however, melanophore distribution was generally uniform. In the 23 young specimens of the series, ventral coloration was in general lighter than in the adults, and considerably more variable in chins and bellies. The chins of nine specimens, or 39% of the young, exhibited uniform melanophore distribution, but in 14 cases or 41% of the young the chins exhibited whitish, flesh-colored areas completely devoid of melanophores. These melanophore-free areas varied from 10% to 60% of chin area, and in eight of these cases were 50% or more. With respect to bellies, 14 animals (61% of the young) had uniformly-distributed melanophores, but nine animals (39%) exhibited flesh-colored melanophore-free areas; in six animals this represented failure of melanophores to reach the ventral midline, leaving a flesh-colored longitudinal strip approximating one-fifth of the body in width; in two animals there were pectoral flesh-colored areas; and in one case a general unevenness of melanophore distribution left several small melanophore-free areas. Ventral coloration as to ground-color in the 23 young animals may be summarized as follows: (a) nine animals or 39% evinced uniform melanophore distribution on both chin and belly, (b) nine animals or 39% had melanophore-free areas on both chin and belly, and (c) five specimens or 22% had melanophore-free areas on the chin but uniform distribution of melanophores on the belly. By careful comparison of pigmentation where it existed, it was determined that belly and chin did not differ significantly in pigmentation intensity in these young salamanders except (a) in two cases where the chin was slightly the lighter, and (b) two more cases, the two oldest young, in which the chin was discernibly lighter than the belly. Lateral coloration in the entire series, both young and adult, was generally transitional between that of the dorsum and venter. In the majority of animals this transition was gradual, but in four juveniles and four adults the transition occurred quite abruptly in a band about midway between dorsal and ventral surfaces, thus lending a more contrasting aspect to the upper and lower sides in these eight animals.

Bailey (1937) was the first to call attention to the occurrence of dorsal

red markings on the young of *P. j. jordani,* and Wood (1947) found such on all 29 juveniles studied by him; 50% of them had red color on the head and 90% of them had such on the trunk, while only one specimen had red on the tail. In the 31 specimens reported on here, a careful study showed that red color occurred in three patterns of expression: (a) single flecks, (b) loose aggregations, and (c) compact masses. All of these could be interpreted as degrees of crowding or compactness of the red chromatophores.

The single flecks were scattered, isolated, bits of red color each of which was interpreted as being due to the presence within the skin of a single red chromatophoric cell. One young specimen showed such on the chin, another had flecks on the lower jaw and also ventro-laterally on the head. The most abundant occurrence of flecks, however, was in the eyelids; twenty or 87% of the 23 young and one out of the eight adults exhibited flecks in the eyelids varying in number from three to 15 flecks per eyelid. Two of the young showed additional dorsal head flecks between and in front of the eyes. At trunk levels, five young specimens exhibited flecks dorsally, one had them laterally, and one showed such on the proximal dorsum of the tail. On adults, no flecks were seen posterior to the head.

A second pattern of red color occurrence consisted of red chromatophores which were individually recognizable yet grouped sufficiently close together to form a loose aggregation; the result was red chromatophores mixed in with the general melanophoric ground-color which produced a visual impression best characterized as "rusty." Some such aggregations involved sufficient red chromatophores to make a definite rusty patch, while others involved fewer red chromatophores and produced a less definite rusty smudge. Neither patches nor smudges were exhibited by any of the eight adults of this series. In the young, however, seven animals or 30% of the 23 specimens had rusty patches on the dorsum of the head, and 12 animals or 52% of them had either patches or smudges on the dorsum of the trunk. Varying from three to 12 per specimen, these patches and smudges occurred mostly on the anterior half of the animal, the most posterior occurrences involving the ninth, 10th and 12th intercostal fold levels. A weak tendency toward bilaterality was noted in four animals that afforded seven cases of pairing or approximate pairing of patches and smudges. Two of the young specimens also exhibited patches on the proximal dorsum of the tail.

The third pattern of red color expression was in the red cheek, the hall-mark of *P. j. jordani* and its most striking and distinctive externally-visible trait. Here the red chromatophores existed in heavy concentration and so tightly compacted that individual red units could not be distinguished. Furthermore, these red chromatophores were the chief, if not the sole, chromatophoric elements present in the cheek. Dunn (1926) mentioned three cases out of 37 which lacked the red cheek, and Bishop (1947) stated that rarely the red may be lacking or greatly reduced. In the 31 animals of this series, all had red cheeks but there was variation in the actual amount of red; there were no flesh-colored, chromatophore-free areas since any cheek area not occupied solidly by red was occupied equally solidly by black, though either of these might exhibit a slight interspersal of white, as will be discussed below. Since variation in actual amount of

cheek red appeared to be characteristic of *P. j. jordani,* an effort was made to quantify the expression of this variation.

The ocular lens of a binocular dissecting microscope was fitted with a micrometer ruled into 100 small squares, and the salamander cheeks were observed through this grid of squares. Scale drawings of the cheeks were made on millimeter graph paper whereon each square centimeter was ruled off into 100 square millimeters. By counting the small squares in the completed drawings, relative sizes of different cheek areas could be determined. The resulting values were not absolute but approximate since, in addition to small drawing inaccuracies, there was some error in representing the curved salamander cheek on the plane surface of the graph paper. The red cheek was originally called a "band" by Blatchley (1901), and Dunn (1926) mentioned it as a "stripe." In this effort at reasonably precise measurement, the actual skin area encompassed by the term "cheek" was easily delimited anteriorly, dorsally, and posteriorly by, respectively, the posterior angle of the eye, the postocular groove, and the dorsal extension of the gular fold. The fact that red color normally terminated antero-ventrally at the border of the upper jaw prompted the adoption of a "restricted" cheek bounded ventrally by a posterior extension of the line of the upper jaw border. Bounded thus by anatomical landmarks, the restricted cheek had greater specificity than did whole cheeks which extended ventrally as far as skin was visible in lateral view. Among the eight adults in this series, three showed 100% red in both cheeks whether considered from either restricted or whole cheek standpoint. Other adult cheeks varied from as much as 87% red to as little as 33.5% red in restricted cheeks. Maxima, minima, and means are given in the lower portion of Table 1. Of 45 restricted cheeks measured in the 23 young salamanders, 31 cheeks or 68% of them exhibited more than 70% red; these included five cheeks that were 90% or more red, but among these young there occurred only one 100% red cheek. These relationships, plus those given in Table 1, might be interpreted as presumptive evidence that adults in general have more red in the cheeks than do younger stages, and the study of a larger series which included more adults might prove this to be correct. However, when the percentage of cheek red was observed in a serial and sequential arrangement of all 31 animals by S-V length, mere inspection revealed sufficient inconsistency to discourage an attempt to run a correlation coefficient between cheek red and S-V length.

Review of the previous paragraphs on color and markings in this series of 31 salamanders suggests that the processes of growth and development leading to adulthood involved changes which included: (a) intensification of dorsal melanophoric coloration; (b) population of pigmentless flesh-colored areas of both belly and chin with melanophores; (c) achievement in both bellies and chins of relatively uniform melanophore distribution, but with concentration differences that leave chins lighter than bellies; (d) disappearance of rusty smudges and patches from all parts of the body; and (e) disappearance of isolated flecks of red from all parts of the body except the head. While no clear-cut growth trend could be demonstrated with respect to cheek red percentage in this series, it should be noted that Wood (1947) found no red color in the cheeks of the quite young specimens studied by him; all had white cheeks.

No previous report on *P. j. jordani* has mentioned the occurrence of

white or iridophoric coloration, yet in this series such was observed in three out of eight adults and in 22 out of the 23 young salamanders. The occurrences were chiefly in the form of isolated flecks, each presumed to be due to the presence within the skin of a single iridophoric cell. One adult had such flecks in the eyelids, one had them in a group just in front of the red cheek, and a third adult had flecks in the chin and also laterally in the trunk at the levels of intercostal folds 2, 3, and 4. Among the young salamanders only one specimen of the 23 failed to exhibit iridophoric white anywhere on the body, while 21 or 91% of them had isolated white flecks in the eyelids. In 20 of these the white flecks were accompanied by the red eyelid flecks discussed above; one specimen had the white flecks only. In those that had white eyelid flecks, nine cases showed white nowhere else on the body, while nine more had white flecks sparsely interspersed among the red chromatophores of the red cheek; the white cheek flecks were beneath the red in 8 cases, at the same level in one case. The additional occurrences of white flecks, some of them in combination with those already mentioned, may be summarized as follows: (a) in eyelids and chin, 1 specimen; (b) in eyelids and trunk, 2 specimens; (c) in eyelids and head dorsum, 1 specimen; (d) in eyelids, cheeks, and trunk, 1 specimen; (e) in eyelids, cheeks, and chin, 3 specimens; (f) in eyelids, cheeks, chin, and trunk, 2 specimens. The trunk occurrences were lateral in three cases, ventro-lateral in two.

Thus far not mentioned in connection with iridophoric white were eyelid flecks of a metallic, rich golden-yellow hue here called "brassy." One young specimen had only brassy flecks in the eyelids, but also possessed the regular, bright, dead-white iridophores in the form of 10 flecks near the middle of the chin and 8 more flecks on the left lower jaw. One other salamander, an adult, had brassy flecks co-existing with the dead-white ones in the eyelids to the extent of 22 of the former, 9 of the latter. Chromatophores conforming to the same description as these brassy flecks were studied in *Plethodon cinereus* by Hertzler (1958) and found to be due to smaller iridophores lying deeper in the dermis of the skin. Whether brassy or dead-white, the occurrence of this type of chromatophore presented in this series of *P. j. jordani* a striking parallelism with respect to red color. Presence of red chromatophores on body parts other than the cheek was, in every case except one young specimen, accompanied by white or brassy. Further, the series included two specimens, one young and one adult, in which white flecks occurred unaccompanied by red except in the cheeks.

SUMMARY

Thirty-one specimens of *Plethodon jordani jordani* collected on August 27, 1957, in the Great Smoky Mountains at Indian Gap, Sevier County, Tennessee, proved to include 23 young and eight adult salamanders. In total length the young varied from 32.9 to 66.9 mm, the adults from 92.8 to 117.7 mm. The young animals had relatively wider heads, shorter tails, and more stocky trunks than did the adults. Changes indicated during growth and development to adulthood included: (a) positively allometric growth in trunk length; (b) negatively allometric growth in head length; (c) general intensification of dorsal and upper lateral melanophoric coloration; (d) population by melanophores of pigmentless,

flesh-colored, areas on the belly and chin; (e) achievement of generally uniform melanophore distribution on both belly and chin, but with concentrations such that chins were lighter than bellies; (f) disappearance from all body levels of red chromatophores loosely aggregated into reddish-brown smudges or patches; (g) disappearance from all levels except the head of isolated red chromatophoric flecks. Both young and adult individuals had red cheeks in which the actual red varied from 36.8% to 100.0% of cheek area as delimited by certain anatomical landmarks. Elsewhere on the body the young exhibited reddish patches and smudges, and both young and adults showed isolated red flecks; these were strikingly paralleled by presence of white flecks.

Quantitative Information on *Plethodon jordani jordani* in Terms of Maxima, Minima, and Means

ITEM	ADULTS Max.	Min.	Mean	No.	YOUNG Max.	Min.	Mean	No.
A. ACTUAL MEASUREMENTS (in mm.)								
1. Head length	13.0	11.0	12.3	8	9.0	5.3	6.6	23
2. Trunk length	43.9	35.0	40.7	8	26.6	13.0	18.1	23
3. Tail length	63.2	46.8	56.3	5	31.3	14.0	20.4	18
4. S-V length	56.4	46.0	53.1	8	35.6	18.3	24.7	23
5. Total length	117.7	92.8	107.9	5	66.9	32.9	45.2	18
B. PROPORTIONS								
6. Head length / S-V length	0.24	0.22	0.23	8	0.29	0.24	0.27	23
7. Trunk length / S-V length	0.78	0.76	0.77	8	0.76	0.71	0.73	23
8. Head length / Total length	0.12	0.10	0.11	5	0.16	0.12	0.15	18
9. Trunk length / Total length	0.39	0.35	0.37	5	0.47	0.37	0.41	18
10. Tail length / Total length	0.54	0.50	0.52	5	0.50	0.37	0.45	18
11. Head length / Head width	1.46	1.36	1.41	8	1.47	1.23	1.35	23
12. Trunk length / Head length	3.51	3.18	3.30	8	3.12	2.45	2.75	23
13. Trunk length / Trunk width	5.70	4.61	5.30	8	5.90	3.88	4.64	23
C. PERCENTAGE OF CHEEK RED								
Restricted Cheeks								
14. Right cheeks	100.0	33.5	80.6	7	96.3	44.6	71.4	23
15. Left cheeks	100.0	66.2	91.1	6	100.0	36.8	76.8	22
16. All Cheeks	100.0	33.5	85.4	13	100.0	36.8	74.0	45
Whole Cheeks								
17. Right Cheeks	100.0	17.7	67.6	7	71.1	28.8	46.0	23
18. Left Cheeks	100.0	18.4	77.6	6	66.4	27.0	49.7	22
19. All Cheeks	100.0	17.7	72.2	13	77.1	27.0	47.8	45

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DEPARTMENT OF ZOOLOGY, DEPAUW UNIVERSITY, GREENCASTLE, INDIANA

TWO RECORDS OF ALBINISM IN *EURYCEA B. BISLINEATA* GREEN.—Hensley (1959, Publ. Mus., Mich. State Uni. 1(4):145) in recording the known instances of albinism in North American reptiles and amphibians listed only one record of albinism in *Eurycea bislineata*. A larva, 43 cm. in length, reported by A. M. Banta and R. A. Gortner (1915, Proc. U. S. Nat. Mus., 49:377-379). Within the last year, I have come across two more specimens.

While collecting salamander larvae in a small spring on December 22, 1958, at Little Flower Institute, Upper Darby, Delaware County, Pennsylvania, an albino *Eurycea b. bislineata* larva was taken. It was 27 mm. long and lacked body pigment. Each eye was pink with the exception of two black spots on the iris; one in front of and the other behind the pupil, along the horizontal plane. The albino larvae was take under a rock in the spring with normally pigmented larvae of the same species. In proportions and length it was similar to the normal individuals.

Returning to the same locality on April 22, 1959, a second albino larva was collected. This was 35 mm. long and had the identical color and body characteristics of the first.

Adult *Eurycea b. bislineata* collected at this locality over the last two years have not deviated from the typical color pattern.—*John A. Bartley, Department of Biology, Cornell Universiity, Ithaca, New York.*

Respiratory Functions of the Ophidian Air Sac

By HARRY S. MCDONALD[1]

Attention has recently been directed to the membranous portion of the snake lung, and several possible roles have been tentatively attributed to it, viz., (1) a provision for exposing the vascular lung to inspired air twice during each breathing cycle, (2) a mechanism for cooling the body, or (3) the testes, (4) an aid to maintenance of posterior body form, and (5) a flotation device (Brattstrom, 1959). The last of these (i.e. a "swim bladder") has also been proposed by Beddard (1904; 1906), Bellairs and Underwood (1951), and Klauber (1956). In addition to these suggestions the role of a reservoir of air (to be drawn from in the absence of ventilation) has been attributed to this structure by numerous authors, the first of which (according to Ahrenfeldt, 1955) was Tyson in 1863. Klauber (1956) has further noted that inflation of the air sac may aid in intimidation.

While the air sac may subserve these functions in limited numbers of forms, it is felt that certain aspects of its role in normal respiration, which are applicable to snakes in general, have been overlooked. Its volume can be varied just as effectively as that of the vascular lung, and thus it can participate in ventilation. It can be thought of simply as a provision for obtaining extra *volume* beyond that contained in a vascular sac which possesses adequate *surface* for gaseous exchange.

Conceivably volume changes in the air sac could either supplement those of the vascular lung or replace them. There are reasons why an additional space utilized in both ways might be expected in ophidian lungs.

Direct effect of elongation: Pulmonary gas exchange is dependent on the exposed vascular area of the lung and the concentration of gases presented to it. In order to supply the oxygen needs of the animal there is presumably a compromise between several factors, including: (a) balance of blood volume between the pulmonary and systematic circuits, (b) tidal volume as a fraction of total pulmonary space, and (c) frequency of breathing movements. Because of this interdependence the surface-volume ratio in a saccular lung assumes some importance.

As the form of a cylindrical sac with constant surface area is elongated its volume decreases. More specifically, if the radius is divided by a factor "x" the original surface can be maintained by multiplying the length by the same factor "x," but to preserve the original volume the length would have to be multiplied by the *square* of factor "x." Thus the elongation which is so evident in the viscera of snakes could not have occurred without some modification of the surface-volume relationships. However, in the case of the lung it is not the total surface but only the *vascular* surface that is critical, and therefore the volume deficit could be remedied by a nonvascular extension.

Klauber (1956) cites the lung volume and lengths of the vascular and nonvascular portions of the lung in a specimen of *Crotalus r. ruber*. Assuming a uniform radius, a value can be estimated for that dimension

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[1]Postdoctoral Fellow, National Heart Institute.

also. The ratio of length to diameter in this lung is approximately 60:1, and 53% of its length is vascular. Extrapolating back from this information one finds that such a condition could result from elongation of a vascular sac with a length:diameter ratio of 8:1 and a radius approximately twice that of the actual lung in question. It is not suggested that the ophidian lung necessarily evolved along such a mathematically precise course. The example is cited merely to demonstrate that if any importance is attached to the relationship between volume and vascular area a sizable air sac could result from elongating a completely vascularized lung of quite reasonable proportions.

If the air sac were *not* present in the specimen discussed above, the change in lung diameter necessary to exhale or inhale a given amount of air would be increased by approximately 50%. Specimens of *Natrix sipedon* have been examined in which the vascular region accounted for less than 20% of the lung length. In such an animal a uniform decrease in lung diameter of only 10% would expel a volume of air equal to the total capacity of the vascular lung.

Karlstrom (1952) reported that the body region corresponding to the entire lung in *Natrix* and *Thamnophis* seemed to be active only during periods of dyspnea. However, the writer has observed numerous quietly resting specimens in which the ventilative movements extended throughout the lung area, and this is almost always the case if a specimen is at all active or aroused. The discrepancy between our observations may be attributable to the fact that breathing movements in a quiet specimen are of small amplitude and they are not synchronous throughout the lung, activity in the distal region preceding that of the vascular area. Whether its origin stems from a volume deficit or not, there can be no doubt that the air sac *can* greatly facilitate ventilation and that it *does* actually participate in this function.

In addition to disturbing surface-volume relationships, attenuation of the lung would seemingly hinder thorough mixing of its contents. In the absence of a very high turnover per breath this is likely to result in preferential exchange of air in the anterior region of the lung and some degree of stagnation in the distal end. Karlstrom (1952) reported tidal volumes ranging from 0.01-0.02 cc./gram weight of snake, and these values certainly represent small fractions of the pulmonary capacity. Exhaustion of all air from the lung results in extreme flattening of the animal (Brattstrom, 1959), and nothing approaching such a condition can be said to occur during normal breathing. Without a nonvascular extension, the distal end of the actual exchange surface might be exposed to spent air throughout the breathing cycle. As it is, the entire vascular surface is probably exposed to fresh air except during the expiratory phase when the air sac contents move forward. In this latter regard, a type of "rebreathing" similar in some respects to that proposed by Brattstrom (1959) may occur. In examining the breathing cycles of several species it has been noted that a secondary cycle of more vigorous exhalations is superimposed on the primary rhythm at intervals of from six to fifteen breaths (depending on the species) (McDonald, MS). This may well represent a partial flushing of the air sac with addition of fresh air, and if so, the vascular lung would be exposed during successive expirations to air which gradually diminished in oxygen content throughout the secondary cycle. The

importance of any extra exchange taking place during expiration is minimized by the very brief interval which this phase occupies. The slow terminal expiration reported by Randall *et al* (1944) and Karlstrom (1952), which would increase the significance of such exchange, was inferred from body volume decrease after inhalation. However, intra-pulmonary pressure recordings indicate that the glottis is closed and no gas flows forward out of the lung at this time (McDonald, MS). The small tidal volumes encountered in snakes render it very unlikely that any significant amount of fresh air is drawn into the air sac during the average cycle.

Inhibition of ventilative movements: As is well-known, snakes have a tendency to secrete themselves in very confining quarters and they are capable of passing through relatively small apertures and channels. It was noted earlier that the air sac reduces the changes in diameter necessary for ventilation. Possibly of greater importance in the present context is the fact that if one region of the body is entirely immobilized ventilation can be maintained by regions that are free. In attempting to record breathing movements by means of mechanical levers and cuff pneumographs it was found that most snakes are very sensitive to pressure on their ribs. Almost invariably the region in contact with the cuff ceases movement and ventilation is taken up elsewhere. It is reasonable to suppose that a similar reaction occurs in nature when a snake passes through a narrow passage.

While this is felt to be a minor point in itself it is mentioned because of its pertinence to the discussion that follows.

Anatomy of snakes and their mode of feeding: As long ago as 1805, Cuvier recognized that the location of the lung above the esophagus and stomach in snakes might well lead to embarrassment of pulmonary function after a large meal, and he suggested that this might contribute to the lethargy which typically follows feeding. Varied opinions have been expressed concerning the effect of feeding upon respiration, and there are two possible sources of difficulty to be considered: (1) blockage of the air passage, and (2) interference with ventilative movements.

George and Varde (1941) suggest that at the beginning of swallowing the trachea will be partially choked, and that during the ensuing stress air from the posterior region of the lung will be utilized. However, Broderip (1825) noted that Boids frequently paused during swallowing and breathed by protruding the glottis. This phenomenon has since been observed in many species and is now considered characteristic of snakes in general (Bellairs and Underwood, 1951). Thus it appears that access to "stored air" is not generally necessary during the swallowing process *per se*, and it certainly could not sustain the animal if blockage existed after swallowing was completed.

While complete closure of the air pathway does not seem to constitute a common problem, it is obvious that the presence of a large food mass in the alimentary tract cannot fail to exert some pressure on the lung. Cope (1894) and George and Varde (1941) felt that impairment of "bronchial" respiration in this way might be severe enough to account for the existence of the tracheal lung in those forms which possess it.

The posterior limit of the body region that may be distended by undigested food is fairly well indicated by the gall bladder, since it lies at the level of the pyloric valve (Ahrenfeldt, 1955). Expressing location as

the relative distance from the head in terms of per cent total body length (exclusive of head and tail) Thompson (1914) found that the gall bladder in twelve species was located between 54% and 67%. In *Crotalus mitchelli pyrrhus* it lies at 66% (Klauber, 1956), and in *Natrix sipedon confluens* and *Lampropeltis getulus californiae* at 55% and 66% respectively (personal observation). In none of these fifteen species does the vascular area of the lung extend as far as the gall bladder. George and Varde (1941) examined nine species of Indian snakes (one of which had also been studied by Thompson), but they noted the location of respiratory structures only, and reported these in diagrammatic rather than tabular form. However, assuming that the gall bladder (and pylorus) is located in approximately the same relative position as in the preceding species, it is clear from their diagrams that the vascular lung terminates anterior to this organ in all cases. Thus in this entire series of twenty-three forms (which includes Colubrids, Crotalids, Viperids, Elapids and Hydrophids) the vascular lung is so located that its entire length is vulnerable to compression by food items.

Natrix sipedon and *Thamnophis sauritus* often fill the stomach and esophagus with small fish or amphibians when these are abundant, and such engorgement undoubtedly occurs in many other species as well. In ophiophagous forms a similar situation may result from consuming a single prey item. Under such conditions, when both the volume of the lung and the ease with which it may be manipulated are curtailed, the role of the air sac in ventilation would seemingly be enhanced. With this possibility in mind, observations were made on a specimen of *Lampropeltis g. californiae* before, during, and after feeding.

The ventilative movements in this specimen are almost imperceptible when it is quiescent prior to feeding, and it has not yet been possible to determine how much of the pulmonary region is active under these conditions. During moderate activity or handling apparently any region which is not otherwise engaged may carry on ventilation.

In order to observe feeding, a specimen of *Arizona elegans* was introduced into the cage containing the king snake. The latter has a body length of 75 cm., and the *Arizona* was of approximately equal size. Although the prey was attacked immediately, the king snake could not easily subdue it and five hours elapsed before swallowing was completed. Observation was not continuous throughout this period, but on several occasions it was noted that the greater part of the king snake's body was participating in breathing. During the first hour after the *Arizona* had been completely swallowed breathing was vigorous and frequent (approximately 6 cycles per minute), and it involved the anterior 50% of the body. Within the next two hours the active region had been reduced to the anterior 30%, but the breathing rate remained high.

Preserved specimens of this subspecies with body lengths of 60, 75, and 96 cm. were examined, and the vascular region of the lung terminated at 32%, 27%, and 25% respectively. Remnants of the tracheal cartilages extended to the level of the gall bladder (i.e. 66%), but whether the air sac continued beyond this point could not be ascertained. Clearly ventilative movements of the air sac region had supplemented those of the vascular lung throughout most of the above observation period.

A second feeding, during which attention was focused on the swallow-

ing process itself, provided further information. In this case the head of the prey, a *Thamnophis elegans* with a body length of 50 cm., was seized and swallowing began at once. At the end of 35 min. only 7 cm. of the garter snake's tail still protruded. The king snake breathed frequently throughout this period, and the breathing movements were *always posterior* to the distended region of the body. After inspiration the active region contracted and air was forced forward in the lung. Only when the head of the prey approached the estimated level of the gall bladder did posterior ventilative movements cease. By this time only the tail of the garter-snake remained in the anterior esophagus and it was clear that the volume of the vascular lung could be easily manipulated. Further evidence that the air sac does terminate near the gall bladder has since been obtained by compressing the anterior portion of the body. This stimulated vigorous breathing movements that extended to that level but no further. Thus once swallowing is complete the air sac is subject to the same limitations as the vascular lung. However, throughout most of the swallowing process it apparently takes over ventilation completely, while the vascular area remains passive. This is no doubt what Klauber (1956) has in mind when he states, in a general way, that the air sac may be useful during swallowing.

Lampropeltis was chosen for these observations because a prey item which would fill the digestive tract could be offered without fear of exceeding the size of meals taken in the wild. The anterior location of the vascular lung would seem to favor ophiophagy since tracheal dead space is minimized and (as noted above) the slender caudal end of the prey will usually lie in this region.

It is felt that species which possess an air sac extending beyond the pylorus (e.g. *Natrix, Thamnophis, Crotalus*) are likely to continue using it as a bellows even after swallowing is completed. However, results obtained in the laboratory by coaxing or forcing a specimen to fill the esophagus with several food items would not be conclusive. The question would remain as to whether the same amount of food would, or could, be consumed at a single feeding in the wild. Only observations on specimens captured shortly after heavy feeding under natural conditions can provide satisfactory evidence on this point.

The Hydrophids present a special case in that the roles classically assigned to the air sac (viz., those of a hydrostatic organ and reservoir) seem to be particularly pertinent to this group. The fact that the lung cavity extends virtually to the cloaca (Beddard, 1904; George and Varde, 1941) supports these lines of thought. However, in *Cerberus rhynchops* (Homalopsinae) the lung is only half as long (much shorter than in many strictly terrestrial forms) and this species is known to remain submerged for hours (Thompson, 1914). Since the Hydrophids feed heavily on eels, which would lead to compression of the greater part of the lung's length, maintenance of adequate ventilation may still be a major factor.

Summary: In the absence of a large tidal volume the air sac is likely to accumulate a stagnant pool of air with low oxygen and high carbon dioxide and water vapor content. This situation, plus the lack of adequate vascularity, would seem to argue against any significant role in the exchange of gases, including water vapor, or heat. Roles as an air reservoir

or hydrostatic organ are apparently of importance only to the Hydrophids and other aquatic forms, although only in the former is the air sac characteristically larger than in most terrestrial snakes.

Anatomical considerations suggest that it may play a necessary role in ventilation, and that this function is probably of particular importance in connection with feeding. Observations on living specimens indicate that the air sac does contribute to the ventilative effort, and in some cases, as during swallowing, takes over this function entirely from the vascular lung.

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ZOOLOGY DEPARTMENT, UNIVERSITY OF CALIFORNIA,
LOS ANGELES, CALIFORNIA

Observations on Geckos Allied to *Sphaerodactylus lineolatus*

By CHAPMAN GRANT

Colonel Charles A. Rowan, U.S.A., allowed me to visit at Fort Clayton, near the Pacific terminus of the Panama Canal, during February and March, 1958. Mr. Marvin Keenan of the U.S. Malaria Control secured for me a series of 16 males and 15 females. In December 1958, Mr. Keenan sent me 34 additional specimens, 12 males, 19 females, and 3 immatures (all UIMNH), all taken in mangrove swamps near Ft. Kobbe on the Pacific side.

These are readily identified by the original description of Lichtenstein and von Martens (Nomen. Rept. Amph., Mus. Zool. Berlin, 1856: 6): "Sphaeriodactylus [sic] lineolatus nob . . . Veragoa [sic]. Stuck 3 . . . squamis dorsi aequalibus, granularibus. Rufescens, capite supra linea mediana et utrique tribus lateralibus nigricantibus ornato, dorso fusco-vermiculato. Long. a rostro ad caud. bas. 1¼", caud. 1¼"." Freely translated: *S. lineolatus* n.sp., Veragua, Panama. Three specimens. Dorsal scales of equal size, granular. Reddish, top of head with a median line and three black lateral lines along sides of head; dorsum vermiculated with brown; s-v, 1¼".

Comparing this series with Taylor's account (1956, Univ. Kans. Sci. Bull., 38:40-45) purportedly of this same species from Costa Rica makes it appear that Taylor had more than one species in hand, all identified as *lineolatus*. Some resemble a basically different group represented by *glaucus* Cope of Yucatán.

This genus is composed of species usually less than two inches s-v (snout to vent) which have frequently been described from characters such as labials, head scales, shape of head and snout, etc. which are useful principally in distinguishing larger forms.

Specific characters in this genus are the ontogenic, sexual and individual colorpatterns, size, shape and surface of dorsal scales, shape and size of escutcheon of males and locality of capture.

Lichtenstein and von Martens obviously selected the most striking features: 1) dorsals granular and of equal size; 2) a median and three lateral black stripes on head; 3) dorsum vermiculated with brown; 4) Veragua, Panama.*

The describers would hardly have omitted mention of more outstanding features, such as a large black scapular spot or a pair of black sacral spots (usually outlined with light) had any such features been present on the specimens that they had in hand. One of Taylor's figures of *lineolatus* (:42, fig. 8) shows 4 individuals, 3 with the black sacral spots typical of *glaucus* and the fourth corresponding with the descriptions of *imbricatus* in which the reticulation extends to shoulders only. Another figure (:44, fig. 9) is captioned "*S. lineolatus* Andersson," but Andersson was the describer of *imbricatus*, not *lineolatus*. This figure (9) represents the escutcheon of a male with the modified scales extending to the knees. This feature is of specific value and exists in *glaucus*, but never in *lineolatus*. Dr. H. M. Smith kindly sent me some specimens of *glaucus* from Tabasco the males of which had escutcheons extending to knees. A rediagnosis and description seems advisable.

Sphaerodactylus lineolatus Lichtenstein and von Martens.

Diagnosis. Intermediate between *pacificus* Stejneger, from Cocos Islands off Costa Rica, and *imbricatus* Andersson from Costa Rica. Male escutcheon of *pacificus* consisting of 10-16 juxtaposed scales in a small, ill-defined patch; in *lineolatus* of 23-32 juxtaposed scales in a compact transverse ellipse; in *imbricatus,* 60-68 scales in an irregularly edged patch. Head of male *imbricatus* reticulated to shoulders and chest; in *lineolatus,* head, dorsum and upper sides of limbs and tail reticulated; *pacificus* lacks reticulation. No tendency of escutcheon to extend toward thigh in these 3 species as it does in *glaucus.*

Description (UIMNH 42303, a dark phase male). Habitus as in the genus; s-v 28 mm.; escutcheon of 25 scales, juxtaposed and in a symmetrical transverse ellipse; dorsum with minute, juxtaposed granules, neither ridged nor keeled, 28 in s-d (standard distance: tip of snout to center of eye); scales of venter larger, cycloid, slightly imbricate, about 15 in s-d. Colorpattern: dorsum and upper surfaces of limbs and tail reticulated black and white; head with median and 3 lateral black stripes; throat black with white maculations; belly dark, escutcheon prominently white.

Variation. Light colored adult males with markings brown and narrower, leaving broader areas of the white background; throat white with black maculations instead of reverse. Partly grown specimens of

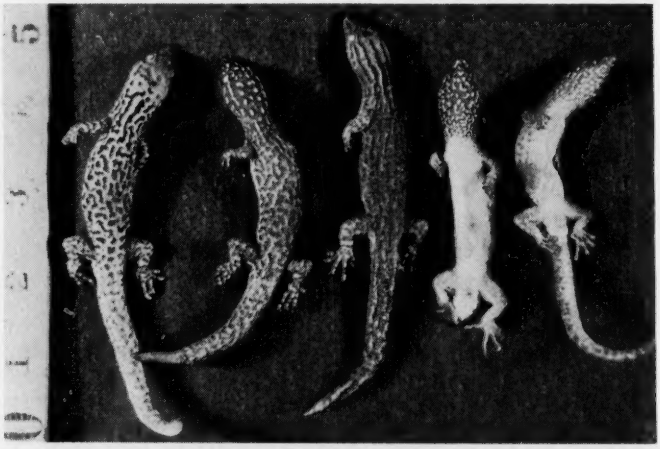

Fig. 1. *Sphaerodactylus lineolatus,* all males; counting from left, 1, apparently a fully colored adult; 2, intermediate in which head stripes are breaking up before disappearing and brown dorsum is developing reticulation; 3, mature, but not showing much tendency to begin adult coloring, but the hatchling cross stripes have entirely disappeared; 4, venter of specimen in same color stage as 2; note compact, transverse escutcheon which does not have any tendency to extend along thighs; 5, older specimen wherein the black throat with white maculations is turning into a white throat with black maculations.

either sex same colorpatterns as dark adults. Generally in this genus the ontogenic colorpattern change in males is a lightening and a reduction or loss of some or all pattern. This species may be similar, but the series of 65 specimens leaves doubt since the escutcheons in dark males are as fully developed as in the light males.

Females lack the escutcheon. They occur in both light and dark phases. The dark ones may have several almost black rhombs along dorsum corresponding to the positions of the crossbands of hatchlings. The nuchal rhomb occasionally contains two minute white specks reminiscent of the "mask" pattern so common in the West Indies. The light females are brown, lacking distinguishing pattern. Ventrals, chin and throat minutely specked with melanin along edges of scales in all females. Hatchlings have a narrow cross stripe behind ears, another anterior to forelegs, one at midbody, another just anterior to hind legs and 6 black rings on tail.

Discussion. S. lineolatus imbricatus Andersson 1916 (Med. Goteborgs Mus. Zool., 9:5), type locality Costa Rica, is a form the describer stated had granular dorsals yet he named it *"imbricatus";* by definition a granular scale cannot be imbricate. Either the describer lacked sufficient magnification or the description is based upon specimens of at least two species or the selection of the name was inappropriate.

Dunn (1940, Herpetologica, 1:189-90) assigned "all *Sphaerodactylus* material I have seen from Panama, Costa Rica and Nicaragua" to *lineolatus.* Apparently on the strength of this sweeping statement, Taylor (:45) dropped the trinomial. More collecting between Costa Rica and Panama may reveal that *imbricatus* is a subspecies of *lineolatus.*

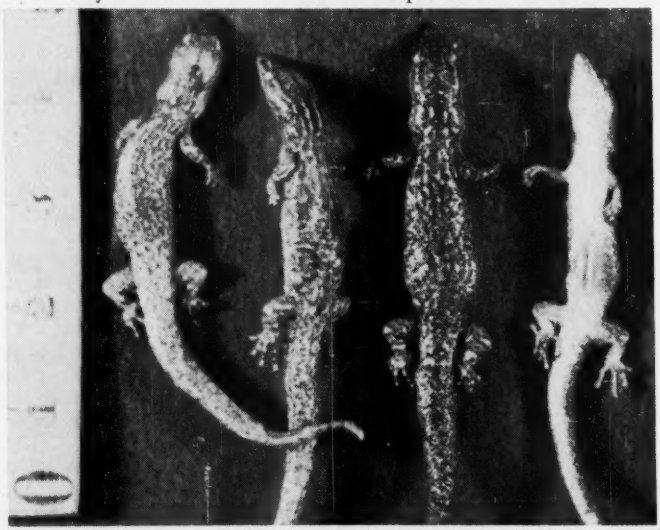

Fig. 2. *S. lineolatus,* all females, all showing "goiter-like" neck swelling; note white throat and undersides.

In Taylor's key (:33) the dorsals of *imbricatus* are said to be "strongly imbricate and keeled." In his description of species (:47) he says: "dorsal scales ridged, juxtaposed . . ."

An unusual modification in *pacificus, lineolatus* and *imbricatus* is the "goitre-like" swellings on each side of the neck of the females only. In a small series the puffed neck might be considered an artifact. Taylor noted this swelling in *pacificus* (:37): "Most of the females (but none of the males) have a goitre-like swelling on each side of the neck . . . within the swelling, a sac filled with a calcareous deposit, connecting with the ear cavity." His Fig. 5 is of 3 *pacificus,* the center one with a slight swelling on the right side of the neck. In his cut of *imbricatus* (:46, fig. 10) the left specimen, a female, shows a large swelling on each side of the neck, but no mention is made of it in the text. Barbour (1921, Mem. Mus. Comp. Zool., 47:pl. 1) shows *pacificus* with a greatly swollen neck without a remark in text or mention of sex. His Pl. 6 shows *gilvitorques* with swollen neck without mention of sex, but a text reference (:252) ". . . head broad and swollen . . ." probably refers to the neck. In my series of 30 adult female *lineolatus* from Ft. Kobbe, Panama, 13 have distinct swellings; I have handled literally thousands of this genus throughout the West Indies and have heretofore encountered the swollen neck only on Mona Island, west of Puerto Rico.

*The describers stated that "Veragoa" was the type locality. Taylor supposed that this was a misspelling for Veraguas which is an extensive Province of Panama reaching from the Atlantic to the Pacific. Within this Province there is an area known as Veragua which was originally confined to the islet of Escudo de Veragua off the northwest coast. This area later came to include Panama City and hence the area now occupied by Fort Kobbe. The describers probably had in mind Veragua (no final "s") instead of Veraguas. In either case the type locality cannot be pinned down with sufficient accuracy for this highly variable genus. There is no town or specific locality bearing either of these names.

The following paragraphs from a letter by Dr. Alexander Wetmore, dated April 17, 1959, justifies the assumption that the type locality was on the Pacific side since Mr. Keenan has found *lineolatus* numerous there and has been unable to find any on the Atlantic side of the Isthmus.

"Veragoa and Varagoa without doubt are misspellings of the ancient term Veragua. In the early period when the isthmus of Panama was a part of Colombia, the name of the present province of Veraguas was usually spelled without the "s." The province runs clear across the isthmus from the Pacific coast to the Caribbean. The section on the Pacific side is the one in which the older scientific work was done since this was the area that the Spanish colonists developed early and the one where towns and trails leading between them were found. The Caribbean coast, until the last 20 years, has been a wild section where travel was difficult and where little scientific work was done.

"I am not familiar with the species you mention but assume it was one that was described some time ago. In that case I would think there would be no reason to suppose that it was not taken on the Pacific side of the isthmus."

ROUTE 1, BOX 80, ESCONDIDO, CALIFORNIA

Systematic Variations in Tadpole Teeth with Notes on Food

By KENNETH L. GOSNER

Observations on tadpole "teeth" have been largely confined to low-power microscopic examination to determine specific differences in the number and relative lengths of tooth rows. Systematic variations also occur in the ultrafine structure of individual teeth as indicated by Héron-Royer and Van Bambeke (1889). These authors studied European tadpoles and no equivalent survey of American forms appears to have been made. In the present study thirty-six species (42 forms including subspecies) were examined, all but two of which are North American, the exceptions being neotropical.

Grateful acknowledgment is due the following for the gift or loan of specimens: Arthur N. Bragg, University of Oklahoma; Doris M. Cochran, U.S. National Museum; E. B. S. Logier, Royal Ontario Museum of Zoo. and Paleo.; Neil D. Richmond, Carnegie Museum; Robert M. Storm, Oregon State College; E. Peter Volpe, Tulane University; Daniel C. Wilhoft, Museum Vertebrate Zoology, and Richard G. Zweifel, American Museum of Natural History.

Under low magnification, larval tooth rows appear comblike and strongly pigmented. The projecting part of each tooth is the outermost of a series of horny replacement elements, for which the term "tooth" will henceforth be reserved, derived from individual epithelial cells. Histological details were described and figured by Héron-Royer and Van Bambeke (*op. cit.*). Three regions are recognized in each tooth, a distal usually spatulate part, the *head*, a middle section, the *body*, and a basal open and expanded part, the *sheath*, Fig. 1. Systematic differences occur mainly in the form and degree of denticulation of the head.

Preliminary treatment consists of macerating and bleaching the specimens overnight in strong potassium hydroxide solution at room temperature or for several hours at 60°-65° C. Permanent microscope slide prepa-

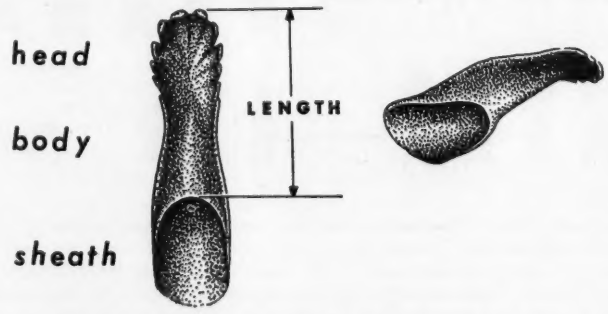

Fig. 1. Tadpole teeth showing method of measurement at left and three-quarter view at right.

rations were made by using glycerin jelly as an imbedding medium. When sufficient material was available the entire oral disc was mounted with tooth rows intact. To obtain a clear conception of three-dimensional form, however, it is necessary to tease the rows apart, dispersing the teeth in different attitudes.

Tooth length, Fig. 1, was measured with an eyepiece micrometer disc. The size range, in microns, in "mature" tadpoles is from 14.7 in *Ascaphus truei* to 72.0 in *Rana macroglossa.* In fifteen ranids, the mean was 45.4, range of averages 30.9-61.6; in 10 hylids, mean 31.2, range of averages 24.1-46.8. The shorter length in hylids is due mainly to reduced tooth *body* length rather than to over-all diminuition. In *Bufo* (3 forms), and *Scaphiopus* (2 forms), the mean was 38.0. There is individual variation in size at equivalent growth stages, and peripheral teeth are frequently smaller than those in parts closer to the horny beak. In *Ascaphus,* regional variation in size is correlated with variation in tooth form, Fig. 2, L. Ontogenetic changes in length were examined in three ranids, *R. palustris, sylvatica* and *clamitans;* Taylor and Kollros (1946) Stage VIII-XIII larvae have teeth 2.2-2.6 times longer than those at Stage I.

Most North American anuran larvae have the margin of the toothhead denticulated. This form occurs in the toads, *B. woodhousei fowleri, B. t. terrestris, B. t. americanus* and *B. punctatus;* in most species of *Hyla, andersoni, gratiosa, femoralis, cinerea* and *versicolor,* and most *Pseudacris* species, *nigrita feriarum, streckeri, brachyphona* and *clarki,* Fig. 2, A, B. The number of serrations in hylids varies from 5-15, (5-10 in *Pseudacris,* 7-15 in *Hyla*), and in toad larvae from 8-14. Seven ranids also have teeth of this type, *R. septentrionalis, sylvatica, virgatipes, palmipes, boylei, macroglossa* and *aurora,* the number of serrations ranging from 6-15, Fig. 2, D-G. In the preceding forms the serrations are usually in an evenly graded series diminishing in size laterally, but in several hylids, *H. ocularis, P. brachyphona* and *P. streckeri,* and in *Rana aurora* one or more medial denticulations frequently are disproportionately large. A reduction

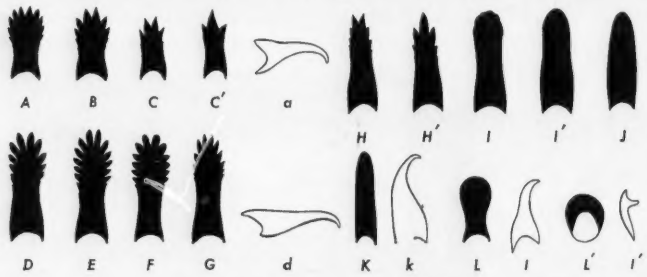

Fig. 2. Systematic variation in tadpole teeth. Side view shown in open outline. A. *Hyla v. versicolor,* B. *Pseudacris streckeri streckeri,* C. *Hyla crucifer crucifer,* D. *Rana sylvatica,* E. *Rana boylei boylei,* F. *Rana macroglossa,* G. *Rana septentrionalis,* H. *Rana clamitans melanota,* I. *Rana catesbeiana,* J. *Rana areolata areolata,* K. *Scaphiopus holbrooki,* L. *Ascaphus truei.* Teeth not drawn to equal scale.

in the number of serrations occurs in some hylids and ranids accompanied by increased variation in form, Fig. 2, C,H. Thus, denticulations are only 2-6 in *Hyla crucifer, Pseudacris brimleyi, Acris gryllus,* (including *g. gryllus, g. crepitans* and *g. blanchardi*), *Rana clamitans, grylio* and *heckscheri.* In *R. catesbeiana, areolata, pipiens, pretiosa* and *palustris,* continuous variation was found between teeth with denticulations 2-6 and those lacking serrations entirely, Fig. 2, H,I,J. Non-serrate teeth appear to predominate in *palustris, areolata* and some *catesbeiana,* but are uncommon in *pretiosa, pipiens, grylio* and *heckscheri.*

Only nondenticulate teeth were found in *Scaphiopus,* (*holbrooki, hurteri* and *hammondi*) and *Ascaphus.* Those of spadefoot tadpoles are long, slender and clawlike, Fig. 2, K; slight differences were found between *hammondi* and the eastern forms, *hammondi* having somewhat broader teeth similar to those of *R. areolata,* Fig. 2, J. Two types are present in *Ascaphus;* peripheral teeth are longer, averaging about 25 microns, and broadly spatulate, whereas those in rows adjacent to the beak are compact and caplike, Fig. 2, L.

Before discussing differences in tooth form in terms of phylogenetic relationships, it is imperative to seek evidence of adaptation and non-systematic variation. Tooth form does not change much during growth. Taylor and Kollros Stage I larvae of *R. sylvatica, clamitans* and *palustris* have smaller teeth than those in Stage IX or later, but the form of the tooth and, in particular, the denticulation pattern remain essentially unchanged. Differences in tadpole size or body form do not appear to be directly related to tooth form; thus, larvae as different morphologically as those of *H. versicolor, B. w. fowleri* and *R. virgatipes* share similar denticulation patterns. Habitat differences, *per se,* do not appear responsible; hylids from different ecological situations preserve a common tooth form as do species of *Rana* from such diverse habitats as quiet semi-permanent pools, (*sylvatica*), strongly acid pine barren bogs, (*virgatipes*) and moving streams, (*boylei*). Conversely species with dissimilar tooth elements may be collected simultaneously; note that tadpoles of *Ascaphus* and *R. boylei* are stream dwellers but with different tooth forms.

Among environmentally induced differences are those ascribed to wear or damage. Thus, teeth were found with serrations blunted or worn through use, but replacement teeth exhibited the typical form of the species. In a few collections a considerable proportion of larvae have atypical mouth parts with irregular tooth rows, few replacement elements and aberrant tooth forms giving indication of hard use.

Food—Obviously, tadpoles of different species, though existing in the same habitats, may employ different methods of feeding or select diverse materials for ingestion. Little information on these points appears to have been recorded; the question was examined, therefore, in some detail through investigation of intestinal tract contents. Twenty-eight samples were selected representing eleven species from nine New Jersey localities. In each case material was taken from a 5-10 mm. segment of upper digestive tract of one to four larvae. An effort was made to examine samples taken simultaneously, and twenty-one are from collections in which two to five species were taken at the same time. Contents were smeared on standard microscope slides and covered with glycerin jelly and a cover slip. Most of the samples were three to five years old when examined, but all

had been preserved immediately in the field, and ingested materials were in excellent condition.

Algae were universally present, and it is probably no exaggeration to estimate several dozen species present in certain samples. Desmids and filamentous forms were most common, both occurring in 79% of the larvae. At least eleven desmid genera were identified in tadpoles of *R. sylvatica, R. pipiens sphenocephala, H. c. crucifer* and *Pseudacris nigrita kalmi* collected May 22, 1954 in a shallow flooded sand pit at Lower Bank, Burlington Co. and ten desmid genera were in *H. andersoni* larvae taken June 29, 1954 at Stafford Forge, Ocean Co. The desmids *Closterium, Cosmarium* and *Staurastrum,* were present in nine samples and *Pleurotaenium, Tetmemorus, Euastrum, Hyalotheca, Gymnozyga* and *Micrasterias* in four or more. Water in New Jersey Coastal Plain localities, (from which the above samples were collected), is usually somewhat acid, between pH 5.5-6.6 in temporary pools according to Gosner and Black, 1957, whereas pine barren endemics, *R. virgatipes* and *H. andersoni,* are commonly found in situations with even lower pH. Desmids were absent only in *R. palustris* and *H. crucifer* tadpoles from a limestone pool in Sussex Co. These observations are in accord with the general opinion that desmids favor somewhat acid water. Filamentous green algae frequently constitute much of the bulk of ingested material. Of these, *Oedigonium* was noted in eight samples, *Zygnema, Spirogyra* and unidentified forms less frequently. Green algae were the most abundant algae in quantity and variety, but blue-green algae were also conspicuous. *Nostoc* was present in seven samples and was important quantitatively in a Sussex Co. *R. palustris-H. c. crucifer* collection. Other blue-green forms tentatively identified were *Croococus, Merismopedia,* several forms of Rivulariaceae, *Spirulina* and *Anabaena.* Blue-green algae were relatively more numerous in the limestone pool samples, as were diatoms. The latter occurred in 36% of larvae but were abundant only in the Sussex Co. collections.

Coarse plant material was present in greater or lesser amounts in most samples. Conifer pollen was found in 75% of collections including one from Sussex Co. and those from the Coastal Plain where pitch pine, *Pinus rigida,* occurs in close proximity to most of the collecting sites. In *R. sylvatica* from Lower Bank, pollen made up the bulk of ingested material.

Animal remains were found in most collections. Of these, testate protozoans, (*Arcella* and diffflugids), were in 61% and dinoflagellates, (*Peridinium* usually), in 21%. Rotifers, (*Monostyla* and *Keratella*) and water fleas, (*Chydorinae* and others), were found in 39% of samples, nematodes in 21%, water mites, (*Hydracarina*), in 18%, unidentified arthropod fragments in 14% and copepods in 7%; a single gastrotrich was noted. Anuran larval teeth were found in three samples. In the case of rotifers and water fleas no whole animals were recovered.

Usually a number of micro-organisms was common to all larvae taken simultaneously; conversely each sample usually contained a few items not found in the others. Some ecological separation of tadpoles of different species apparently occurs. Thus, at Lower Bank, pollen was abundant in *R. sylvatica,* but filamentous algae relatively scarce; in *R. pipiens sphenocephala, P. n. kalmi* and *H. c. crucifer* the reverse was true. At Stafford Forge, large desmids were abundant in *P. n. kalmi, H. c. crucifer* and *H.*

andersoni, but not in *B. w. fowleri.* At Swartswood Lake, diatoms and blue-green algae were plentiful in *R. clamitans,* but scarce in *R. p. pipiens;* by contrast filamentous algae were common in *pipiens,* scarce in *clamitans.*

In the absence of data on the distribution of algae, invertebrates and other edible materials in the pools, digestive tract analysis is necessarily somewhat inconclusive. The data suggest that specific differences in feeding behavior are not extreme, and no positive relationship between tooth form and food preferences was uncovered. It should be noted that the claw-like teeth of *Scaphiopus* larvae appear to be suited to stripping animal tissue from dead or injured prey. This is assumed to be the usual fare of these tadpoles, but some spadefoot tadpoles evidently are omnivorous. Thus, larvae collected near Hornerstown, Monmouth Co. contained the following: green algae including three genera of desmids, four genera of blue-green algae, pine pollen, and, among zoological remains, rotifers, dinoflagellates, testate protozoans and nematodes.

Taxonomic Considerations—Despite the expectation that oral structures are particularly apt to adaptive change, it is also reasonable to suspect that differences may reflect phylogenetic relationships. For example, certain details of oral disc structure are constant in North American tadpoles and provide criteria for family identification. With few exceptions these larvae are relatively unspecialized morphologically and differences in mouth parts between most species are not spectacular.

The larval teeth of *Scaphiopus* and the closely related European, *Pelobates,* are very similar, as are those of *Bufo* and *Hyla* tadpoles in the two areas. Interest in dental variations as a potential indicator of phylogenetic relationship centers on *Rana,* however, where extremes of tooth form occur within a single genus. Before examining this question, generalizations regarding denticulate vs. nondenticulate teeth require attention.

Based on their presence in larvae of the primitive families, *Liopelmidae Pelobatidae* and *Discoglossidae,* Noble (1927) apparently held the opinion that nondenticulate teeth represent the primitive condition. This view is open to question. Denticulate teeth occur not only in higher families but also in discoglossids; Héron-Royer and Van Bambeke (*op. cit.*) found fully denticulate teeth in *Discoglossus, Bombina* and *Alytes.* Among pelobatids nondeticulate teeth occur in *Scaphiopus, Pelobates* and apparently in other Old World genera. Note that in *Pelodytes,* a genus whose removal from the Pelobatidae is advocated by Zweifel (1956) and others, the larval teeth are somewhat crenellated; also, the oral disc of *Pelodytes* is indented (emarginate) according to Héron-Royer and Van Bambeke's figure, whereas in *Pelobates* and *Scaphiopus* it is not. Slight crenellations are also present in the large spatulate teeth of *Ascaphus.* Larvae of both *Ascaphus* and *Scaphiopus* are specialized, the former markedly so, both ecologically and morphologically and the latter at least in carnivorous tendencies and in potential for extremely rapid development. It is reasonable to suspect that tooth form in these species may also be specialized. As previously noted, a reduction in the number of denticulations is found in certain hylids and ranids suggesting an intermediate condition between denticulate and nondenticulate teeth. Two of the hylids with this modification, *Acris* and *Pseudacris brimleyi,* seem unlikely as "central" or necessarily primitive forms. The larvae of *Acris* are as atypical of North American Hylidae as are the adults. In the present study, there-

fore, nondenticulate teeth are considered as independently *derived* types.

Larval tooth form is likely to be of minor value as a taxonomic trait, but the question is worth exploring, especially in view of the scarcity and ambiguity of criteria currently relied upon for intrageneric comparisons. A brief examination of these data follows, mostly in terms of North American ranids, comparing tooth form with other criteria and particularly with those relating to life history.

The forms *R. catesbeiana, clamitans, grylio, heckscheri, septentrionalis* and *virgatipes* share certain traits; pronounced sexual dimorphism in tympanum size and less conspicuous dimorphism in throat color; habits predominant aquatic; four species lack dorsolateral folds, which are usually present in one species, *clamitans,* and variably present or absent in *septentrionalis;* four species deposite in floating films; eggs of all are relatively small, (averages from 1.3-1.6 mm in diameter, mean maximum vitellus diameter 1.78); larvae grow to large size and normally over-winter before metamorphosis; larvae with labial tooth formulae usually 2/3. There are additional similarities in adult form and coloration. Relationships within this group, (if indeed they are a natural assemblage), are difficult to unravel. Wright (1923) considered *virgatipes* and *septentrionalis* to be closely related; various authors were impressed by resemblances between adult *grylio* and *virgatipes* whereas Wright (*op. cit.*) noted similarities between the eggs and larval mouth parts of *grylio* and *clamitans.* Experimental hybrids between *catesbeiana* and *septentrionalis* were obtained by Moore (1949), but other crosses were incompatible. The foregoing is not an exhaustive review of opinions on relationships within the group, but will serve to indicate their diversity.

Aronson (1943) discusses the evolution of ranid spawning behavior and suggests that deposition in floating films has superceded spawning in masses in some forms, and Moore (*op. cit.*) pointed out the adaptive value of floating films for development at high temperatures. In this connection we may note, first, that *virgatipes* and *septentrionalis* are the only species in the group depositing globular egg masses, and second, that all of these species including *septentrionalis* are "southern" either in geographical distribution or in choosing warm weather for spawning. Turning to tooth form we find *virgatipes* and *septentrionalis* with more fully denticulate teeth (another "primitive"? trait) than the other forms. The latter have reduced denticulations and in some *catesbeiana,* nondenticulate teeth. Similarly Héron-Royer and Van Bambeke found reduced denticulation characteristic of European "water frogs" to which the present species are thought to be related. Tooth patterns, therefore, appear to confirm the latter relationship as well as the supposed affinity between *virgatipes* and *septentrionalis.* If full denticulation be accepted as the ancestral pattern, the latter species may, indeed, be near the original type of the complex as suggested by Cope (1889). *R. virgatipes* may be regarded as a conservative, even relict form although its somewhat disjunct distribution could be due partly to low reproductive potential. In contrast to other members of the group, which lay 5000 eggs or more (*clamitans* 1000-5000, however), *virgatipes* complements usually number less than a thousand. Livezey and Wright (1947) gave 200-600. Four ovarian counts of New Jersey *virgatipes* were 420, 670, 994, and 1240, mean 830. The center of abundance for this species may well be in the New Jersey pine barrens where it

thrives in a restricted habitat with little competition from other ranids; *clamitans* and *p. sphenocephala* are common in the same area, but there is some ecological separation of the three.

Most herpetologists concede the close relationship of *pipiens, palustris* and *areolata.* These also show affinity to the preceding group; among other similarities, the larval tooth row formulae are 2/3 and larval teeth have reduced denticulation. (Parallel evolution of tooth patterns must be considered, however, particularly since a reduction of denticulation similar to that found in ranids occurs in hylids.) The *pipiens, palustris, areolata* forms differ from most "water frogs" in: being markedly less aquatic; dorsolateral folds consistently present; eggs deposited in globular clusters; lack of sexual dimorphism in tympanum size; tadpoles smaller and usually complete development in the season they hatch. Eggs of these forms average larger, about 1.7 mm in *palustris* and *pipiens* and 2.0 or more in *areolata.* With regard to variation in egg size it may be noted that Moore (*op. cit.*) found *intra*specific variation in *pipiens;* southern populations having smaller eggs (except Mexican *pipiens*). This principle does not necessarily apply in *inter*specific comparisons. Thus, *areolata* and its races are "southern" in distribution and have prolonged breeding seasons extending into the summer, but their eggs are larger than those of *pipiens* and *palustris.* Similarly among "water frogs" the eggs of *septentrionalis,* the most northern form, are reported as slightly smaller than those of southern Coastal Plain endemics, *grylio, virgatipes* and *heckscheri.*

The largest eggs of North American ranids except *areolata* are laid by western frogs, *aurora, cascadae, boylei* and *pretiosa,* averaging 2.0 mm or more, (average of *minimum* vitellus diameters near 1.98). These forms may be related to both wood frogs, *sylvatica,* and to the Middle and South American *macroglossa, palmipes* complex. Judging from difficulties encountered in delineating boundaries between species, subspecies and local populations in the western forms, variation in adult diagnostic traits overlaps in complex fashion. So far as known these frogs lay eggs in masses with complements usually well under 3000. In the preceding ranids the larval tooth row formulae are frequently higher than 2/3, being 3/4 or higher in most; the range of individual and particularly ontogenetic variation in western forms is inadequately known. In *sylvatica,* for example, ontogenetic variation occurs; the usual formula is 3/4, but initially it is 2/3 and in larvae nearing metamorphosis it may be 4/4 or even 4/5. The near relationship of American wood frogs and Old World members of the *Rana temporaria* complex is reflected in the similarity in larval teeth which are strongly denticulated. In *boylei* and *macroglossa,* Fig. 2, E.F. the serrations are deeper laterally than in *palmipes.* In *aurora* and *pretiosa* the tooth head is somewhat narrow and denticulations weaker and fewer, 6-7 in *aurora* and 2-4 in *pretiosa* with some teeth nondenticulate. Note also that in the latter forms the labial tooth row formulae frequently are less than 3/4.

The present study is based on limited samples. Included were *catesbeiana* from N.J., S.C. and La., *clamitans* from N.J. and S.C., *pipiens* from N.J., Ga., S.C. and Oaxaca, Mexico, and *heckscheri* from Ga. and La. Other samples were limited to single localities or states. In some instances only one or two tadpoles were available. Further study of this problem, along with other life history details is particularly desirable in

ranids, but in other genera as well such study may contribute to a clarification of anuran relationships.

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NEWARK MUSEUM, 43 WASHINGTON ST.,
NEWARK 1, NEW JERSEY

Herpetozoa from Guatemala, I.

By HOBART M. SMITH

Between Dec. 1-21, 1958, Major Chapman Grant collected about 500 amphibians and reptiles of 44 species in Guatemala, all donated to the University of Illinois Museum of Natural History. The collections were taken at two localities: (1) Finca El Naranjo, 3800′-6000′, W slope Volcán Santa Clara, Dept. Suchitepequez, and (2) 10 mi. N Chicacao, 700′ near foot of Volcán Santa Clara, Dept. Suchitepequez. Curiously, not a single specimen was found under anything except loose leaves and none arboreal.

Species well known from the general area and worthy of note for locality record are: EL NARANJO: *Eleutherodactylus rugulosus, Basiliscus vittatus, Ameiva undulata parva, Adelphicos quadrivirgatus sargi, Coniophanes fissidens punctigularis, Dryadophis melanolomus dorsalis, Drymobius chloroticus, D. margaritiferus occidentalis, Geophis nasalis, Imantodes cenchoa leucomelas, Leptodeira annulata rhombifera, Micrurus latifasciatus, Ninia diademata labiosa, N. sebae punctulata, Pliocercus elapoides diastemus, Trimetopon hannsteini, T. posadasi;* CHICACAO: *Bufo canaliferus, B. horribilis, B. v. valliceps, Basiliscus vittatus, Lepidophyma flavimaculatum smithi, Ameiva undulata parva, Coniophanes fissidens punctigularis.*

Most of the noteworthy amphibians are recorded hereinafter; accounts of other species are deferred for later review. Measurements in mm. in parentheses.

Eleutherodactylus venustus (Günther). Five, El Naranjo, varying in s-v length from (16 to 30), a first report from Guatemala. These have been compared in detail with Mexican examples of the species and cannot consistently be distinguished in color or structure. They are so distinctly different in both ridge and color pattern from members of the *rhodopis* complex occurring at the same locality that I believe they should not be considered as genetic or other variants of that single-species complex. The paravertebral ridges are usually more widely separated medially than in the *rhodopis* complex wherein they often nearly meet; the paravertebral ridges run posteriorly from midlumbar region to sacrum almost parallel, not diverging to level of ends of the ilia, whereas in *rhodopis* they diverge strongly; the dorsolateral ridges extend forward to level of tympanum, whereas in *rhodopis* they extend only to the level of axilla; one or two straight, faint ridges may be present between paravertebral and dorsolateral ridges, another lateral to the dorsolateral ridge and a pair between eyes, joining the paravertebral ridges near midlumbar region, whereas in *rhodopis* these accessory ridges are not usually recognizable although some scattered tubercles may represent them. Following these ridges, or the primary ones, are broad dark lines, often fused across the dorsum to produce a uniform broad central dark band on back and head; not so in *rhodopis*.

These features characterize and distinguish *venustus* and the *rhodopis* complex.

The El Naranjo specimens are uniform in color pattern, with broad lines along the ridges, not fused but narrowly separated by light streaks; loreal and supralabial region dusky, not barred or with light stripe. They show considerable variation in distinctness of ridges, some having all plainly evident, others with even the primary ridges faint. The same color- and ridge patterns occur in Veracruz *venustus*.

Eleutherodactylus rhodopis (Cope). Seventy-two from El Naranjo, 1 from Chicacao. Two distinct color patterns are represented, one of which has not, to our knowledge, before been reported: varieties A and B. Every specimen can objectively be allocated to variety with certainty. Variety A in turn is represented by three phases, into which all specimens cannot with confidence be placed, although most fall readily into one phase or another.

We have sought in vain for structural features associated with pattern differences upon which these varieties and phases are based. The buccal features, dorsal ridges, palmar and plantar tuberculation and all other characters are identical or have the same range of variation in each infraspecific group. Because of the invariability of separation of varieties A and B, and the unique occurrence of var. B at El Naranjo (and not in Chiapas or Veracruz whence we have examined hundreds of *rhodopis*, including examples only of variety A), the possibility of specific status for these varieties still exists. We have refrained from considering Var. B as a separate species primarily because of absence of supporting structural evidence, the appearance in one phase of Var. A of part of the pattern peculiarities of Var. B (a phase not found elsewhere) and because of what we regard

as the greater probability that, as a product of but one allele, the difference is a discontinuous genetic variant in a single gene pool rather than a reproductively isolated deviate; it seems to be rare indeed, although of known occurrence, that but one genetic difference producing but one phenotypic difference occurs between any two species. Single phenotypic differences are more frequently the product of allele combinations occurring within a single gene pool.

Variety B is characterized most conspicuously by the invariable absence of a sharp dorsal (or medial) limit on the canthus to the loreal pigmentation; the dark loreal pigment extends across the canthus a variable distance onto snout without interruption or fails to reach that level, whereas in Var. A the loreal pigment is abruptly and sharply limited along the crest of the canthus. We suspect that the actual character is the presence of a loreal stripe in A, its absence in B, and that the presence of the stripe interferes with development of vertical labial bars. A second conspicuous feature of Var. B is the invariable presence of labial bars; these sometimes fail to reach the canthus and sometimes they cross it and end on top of snout, but in either case no pigmentary limitation, interruption or peculiarity is present along the canthus. Thirdly, in Var. B invariably small dark subquadrangular blotches are scattered irregularly on dorsum. Fourth, the lower labia are invariably barred; and fifth, the thigh and shank are invariably barred above. Perhaps a sixth characteristic should be added—the lack of variability in these characters throughout the entire series of 29 examples of Var. B.

The remaining 44 *rhodopis,* including the one from Chicacao, belong to Var. A, so designated because of its wide occurrence in adjacent areas. All have (1) a dark loreal stripe sharp-edged at canthus; and (2) labial bars often evident, but merging with loreal stripe and never visible as far as, or beyond canthus.

Phase A1 of *rhodopis* is characterized by lacking quadrangular blotches, having weak bars on legs and little evidence of infralabial barring; usually the general pigmentation above and below is weak—the frog is light-colored—but in some the pigmentation is heavy and the frog of dark appearance, without having dorsal blotches or much evidence of barring. To this phase belong most Mexican examples, as well as the Chicacao example; of the present series it includes 12 (UIMNH 46314-5, 46317, 46319, 46321, 46324, 46328, 46340-1, 46346, 46354, 46497).

Phase A2, represented by 28 specimens, is characterized by presence of at least some evidence of quadrangular dorsal blotches, a barred infralabial region, and distinctly barred legs. The dorsal blotches have not been observed in Mexican *rhodopis,* but are not clearcut in all specimens even of Phase A2. In some dark individuals allocation to this phase is arbitrary.

Phase A3 is represented by 4 dark examples (46339, 46352, 46355-6), with dorsal dark spots, barred infralabia, hind limbs so heavily pigmented that secondary bars are clearly evident between the primary bars, and with numerous, small, whitish, lichenlike flecks scattered over dorsal surface of body. A few similar flecks are present in a few of phases 1 and 2.

Rana maculata Brocchi. The proper nomenclature for the species of *Rana* in Central America is far from secure. In Guatemala four forms

seem recognizable: one clearly is (a) *pipiens,* wide-ranging at all elevations; one is clearly (b) *palmipes,* restricted to the lowlands of both oceanic drainages; a third (c) is a medium sized frog with small tympanum, restricted to uplands on the plateau and Atlantic extension thereof; and a fourth (d) is a large frog similar to (c) but restricted to the Pacific drainage. It is our tentative conclusion that (c) and (d) are subspecies of a single species.

Schmidt and Stuart (1941, Zool. Ser. Field Mus. Nat. Hist., 24: 239-241) were the first clearly to distinguish species c-d; they applied the name *Rana macroglossa* Brocchi (1877, Bull. Soc. Philom. Paris, ser. 7, 1: 177-178) despite Kellogg's (1932, Bull. U. S. N. M., 160: 206) statement that two of the three syntypes of *macroglossa* "are clearly referable to *Rana pipiens,*" whereas "the third, to which the parchment label is attached, has the under surface of the thighs brown and stippled with light flecks. This specimen is questionably referred to this [same] species." It may be noted that Kellogg was not aware of the existence of species c-d, and that his choices in synonymizing *macroglossa* lay between *palmipes* and *pipiens.* It is significant that he rejected *palmipes,* for despite close relationship of *palmipes* and species c-d(see Stuart, 1948, Misc. Publ. Univ. Mich. Mus. Zool., 69: 41-42) we believe that medium sized, long-preserved examples of species c-d (such as the types of *macroglossa*) would more readily be confounded with *pipiens* than with *palmipes.*

Stuart (1948, *loc. cit.*) has already pointed out differences between species c-d ("*macroglossa*") and *palmipes,* placing special emphasis upon the larger tympanum, absence of loreal light streak, more pronounced dorsolateral folds, lesser dorsal spotting and larger size of *palmipes.* To these we add the distinctive sandpaper-like texture of skin in long-preserved examples of *palmipes,* recognizable even in small young; in species c-d as well as in *pipiens* the skin is smooth to the touch even though (in *pipiens*) ridges may be present on the dorsum.

For the same reasons given by Schmidt and Stuart (*loc. cit.*) plus a few other, subjective reasons, we believe like they that the name *macroglossa* was based upon at least one example (the tagged syntype) of species c-d. Schmidt and Stuart (*loc. cit.*) as well as Stuart (1948, *loc. cit.*) seemingly thought of the type locality of *macroglossa* simply as "Guatemala," the only locality given by Brocchi in the Mission Scientifique au Mexique (1881: 12-13, pl. 3, fig. 1), but the original description cites the locality as "plateau de Guatemala," and Kellogg (*loc. cit.*) has verified that expression for the syntypes. The point is perhaps minor but it does narrow the range of possibilities for allocation of the name, virtually eliminating *palmipes* from consideration.

Immediately following the original description of *macroglossa,* in the same article, is a description of *Rana maculata* (Brocchi, 1877, *op. cit.*: 178-179), redescribed and figured in Brocchi's monograph on Central America (1881, *op. cit.*: 13, pl. 3, fig. 2). Schmidt and Stuart (*loc. cit.*) suggested that *maculata* and *macroglossa* might prove synonymous, but they came to no conclusion on this point. For our own part, we regard *maculata* as almost certainly applicable to species c-d, because of precise type locality (Totonicapam, Guatemala) and the characteristic pattern figured by Brocchi and described by Kellogg (*op. cit.*): 206-7). The three

syntypes of *maculata* likewise were referred by Kellogg to *pipiens,* but the description he gives could not well fit that species although it does well fit species c-d.

We therefore conclude that *macroglossa* and *maculata* are indeed synonymous, and that as first revisers we have the privilege of choosing between the two names, page priority having no conclusive bearing on nomenclatural priority. Our choice is *maculata,* because of precise locality and seemingly clear association with species c-d.

This choice leaves *Rana maculata* Taylor from Costa Rica nameless, for the species to which he applied this name lacks vocal sacs and is related to *pipiens,* whereas *maculata* possesses them and is related to *palmipes.* We therefore propose for it the name

Rana taylori sp. nov.

Holotype. Specimen cited in Taylor (1952, Univ. Kans. Sci. Bull., 35: 906) as UKMNH 2978, Peralta, Costa Rica, collected by Marco Tullio. *Paratypes.* Two, same data as holotype, in the UKMNH.

Diagnosis. See Taylor (1952, *op. cit.*: 906).

Description of holotype. See Taylor (1952, *op. cit.*: 906-7).

Assignment of *maculata* to the *palmipes* group is in accordance with Zweifel's review (1954, Bull. So. Cal. Acad. Sci., 53: 131-141), wherein he assigns four species to this group: *palmipes, sierramadrensis, "macroglossa"* (=*maculata* of this paper) and *sinaloae.* It is a curious fact that all the species except *palmipes* have a tympanum of reduced size and inhabit upland areas; *palmipes* has a large tympanum and inhabits lowlands and presumably was the ancestral type from which the upland forms evolved in separate, isolated regions. None of the upland forms has overlapping ranges, although *palmipes* apparently overlaps slightly the ranges of *maculata* and *sierramadrensis.*

Specimens in the UIMNH provide data for range extensions of two of the *palmipes* derivatives. A series of 7 young *Rana sinaloae* is from 18.8 mi. NW Ahuacatlán, Nayarit (UIMNH 8288, 8336-40, 8344); they exhibit the conspicuous white dorsolateral folds characteristic of this species. A second series of 21 specimens from southeastern Chiapas, reported in 1945 as *Rana palmipes* (Taylor and Smith, Proc. U. S. N. M., 95: 605) actually represents a form of *Rana maculata.* The tympanum is small and the skin smooth, in sharp contrast with *palmipes* including specimens at hand from nearby localities in Chiapas (UIMNH 9850-63, Rancho Monserrate, Río Grande; UIMNH 32393-5, Asunción, betw. Tonalá and Tuxtla Gutierrez). This constitutes a new addition to the known herpetofauna of Mexico.

The Mexican *maculata* are, however, much larger than those reported by Stuart from Alta Verapaz (1948, *op. cit.*: 41), none of which exceeded (80 s-v), whereas the largest available from Chiapas reaches (113 s-v) and no doubt larger ones are among the 75 specimens collected at the same localities and now in the collections of the U. S. N. M. and of E. H. Taylor. No size difference between this series and typical *palmipes* is evident, as indicated by Taylor and Smith's (*loc. cit.*) allocation. Mertens (1952, Abh. Senck. Naturf. Ges., 487: 31-32), however, records large *"macroglossa"* (=*maculata* of this paper) from El Salvador, reaching (100 s-v).

It is our conclusion that two geographic races of *maculata* exist. One (A) is a large form occurring on Pacific slopes, represented by material reported from Chiapas, El Salvador, and southeastern Guatemala. Stuart (1954, Contr. Lab. Vert. Biol., 68: 20, 50-51) notes that this form in southeastern Guatemala does not reach elevations in excess of 2000 m., and Mertens (*loc. cit.*) records it up to 1900 m. The specimens from Chiapas came from elevations between 1200 and 6000 ft. as indicated by Smith and Taylor (*loc. cit.*).

A hiatus at higher elevations seemingly exists between the envisioned ranges of form A and the smaller form B, which is restricted to the oak-pine zone at elevations from 2000 to 2600 m. in the highlands of southwestern Guatemala (Stuart, 1951, Contr. Lab. Vert. Biol., 49: 16, 18, 26, 52-53) and to the lower, northern uplands where records are available in Alta Verapaz (Stuart, 1948, *loc. cit.*) and Baja Verapaz (Schmidt and Stuart, *loc. cit.*). To form B both of the names *macroglossa* and *maculata* are applicable; that form is therefore *Rana maculata maculata* Brocchi. No name is available for form A, which we here call

Rana maculata krukoffi, subsp. nov.

Holotype. UIMNH 10526, Finca Juárez, 7 leagues NE Escuintla, Chiapas, May 6, 1940, H. M. Smith. *Paratypes.* UIMNH 10512, 10518, 10527, 10529, 10531, same data as holotype, all adults or subadults (69 or more s-v). *Hypoparatypes.* UIMNH 10513-7, 10519-25, 10528, 10530, same data as holotype, all juveniles (30 or less s-v); UIMNH 10500, Salto de Aqua, near La Esperanza, Chiapas, May 19, 1940, H. M. Smith, juvenile; U. S. Nat. Mus. 112778-92 and EHT sev. spec., same data as holotype (not re-examined); USNM 113762-77, Mt. Ovando, 1200-6000 ft., Chiapas (not re-examined); UIMNH 46211-5, Finca El Naranjo, W slope Volcán Santa Clara, Suchitepequez, Guatemala, Dec., 1958, Chapman Grant (juveniles, 36-48 s-v).

Diagnosis. A member of the *palmipes* group of *Rana,* having large, elongate subarticular tubercles, toe tips expanded and padlike; dorsolateral folds light-streaked in young, well developed and continuous past sacrum; tympanum about half diameter of eye; skin smooth; length at least to 113 s-v; no postympanic ridge; dorsal surface of head and forepart of body not colored differently from rear part.

Description of holotype. Adult female (110 s-v); diameter of tympanum (5) less than half that of eye (11.5 across eyelid opening), somewhat less than orbitotympanic distance (7); interorbital distance (7.5) much less than diameter of eye, slightly less than orbitonasal distance (8) and internasal distance (9); lores rather deeply indented, sides above indentation almost vertical; snout (forward from eye level) about equal (12) to eye diameter.

Choanae large, transverse ovals, about same size as prevomerine dentigerous processes; latter diagonal, the two forming a V, rear tips almost in contact (separated by about 0.5), distance from choanae about equal to greatest diameter of choana, their median transverse axis placed slightly posterior to that of choanae, anterior tip about even with that of choanae, posterior tip extending somewhat posterior to level of rear edge of choanae; Eustachian tube openings slightly larger than choanae; no vocal slits (female).

First finger much longer than second, subequal to fourth; no palmar webbing; a large thenar pad and another at base of digits 2-3; one large subarticular tubercle on each digit except 3rd, with two; finger tips blunt but not expanded; no lateral fringe on hand or arm.

Heels overlapping perhaps (3) with thighs at right angles to body and shank flexed; heel reaching to tip of snout; webbing on foot rather full, reaching to terminal pads although only by a flange on either side of 4th toe; webs notched relatively little between toes; inner metatarsal tubercle (6) 2/5 length of 1st digit from tubercle (14.5) tarsal fold poorly defined; one large subarticular tubercle on digits 1 and 2, two on 3 and 5, three elongate tubercles on 4; tips of digits distinctly expanded, wider than digits.

Skin perfectly smooth above; a broad, low dorsolateral ridge extending about to level of femur; no tubercles on limbs or back; a shallow groove from rear palpebral rictus above tympanum to level of rear edge of jaws.

Color in preservative olive gray above, back faintly mottled with darker brownish gray; an indistinct light line below eye, reaching to level of rear edges of jaws, but scarcely evident below lores, bordered below by dark color; hind legs dimly barred; concealed surfaces of femora mostly dark, with small light areas, some rounded and with dark centers; venter rather uniformly and moderately heavily pigmented; sides of body somewhat darker than back.

Variation. The series at hand from Chiapas, preserved almost 20 years, does not show or shows only dimly in young the dark face mask or the oblique dark line across upper arm as depicted in Mertens' photographs (*op. cit.*: figs. 12, 45). The young from El Naranjo are much like these figures and it is supposed that the Chiapas specimens have faded. The venter is heavily pigmented or with a mottled effect in certain ones; the Guatemala juveniles are especially heavily pigmented. The dorsum has spots clearly evident in some, much as in Mertens' figure 45, whereas in others spotting is scarcely evident; this is true even among fresh specimens. The rear of thigh is characteristically very dark, with relatively little light area.

In larger specimens the tympanum is relatively smaller than in the young, but is at most only slightly more than half diameter of eye. Vocal sac slits are well developed in adult males, but the thumbs are not larger than in females, nor is the tympanum proportionately larger. Largest male (70), one other (68); four large females are among the types, all between (110 and 113 s-v).

Remarks. Stuart (1951, *op. cit.*: 53, pl. 7, figs. 1-2) has described and figured the tadpoles of *Rana maculata maculata,* and Mertens (*op. cit.*) has described those of *R. m. krukoffi.* No difference is apparent from the descriptions. The forms undoubtedly are closely similar at all stages.

Adults of the two subspecies can, however, be distinguished in size (80 max. in *m. maculata,* 113 in *m. krukoffi*) and in expansion of toe tips (none in *m. maculata, fide* descriptions). Differences in color no doubt exist but are not evident in descriptions. An excellent color description from life is given for *m. krukoffi* in Mertens (*loc. cit.*).

DEPARTMENT OF ZOOLOGY AND MUSEUM OF NATURAL HISTORY, UNIVERSITY OF ILLINOIS, URBANA

Two New Species of *Tropidodipsas* From the West Coast of Mexico

By FREDERICK A. SHANNON and FRANCES L. HUMPHREY

Among a collection of reptiles and amphibians secured by the authors in Mexico during the summer of 1957 is a *Tropidodipsas* which does not agree with descriptions of any present forms. Collected on the highway 4-8 mi. E San Blas, Nayarit, 11 P.M. July 18, just after a heavy shower; relative humidity 100%; air 26.0° C. The snake is described as a new species, most closely related to *T. annulifera.* Discussion concerning the relationships follows the description.

Tropidodipsas malacodryas, sp. nov. *

Holotype. FAS No. 12487♂, 4-8 mi. E San Blas, Nayarit, Mexico. Collected by F. A. Shannon and F. L. Humphrey July 18, 1957.

Diagnosis. Undoubtedly a *Tropidodipsas,* notwithstanding the low maxillary tooth count of 8-8. Scales in 15 rows; weakly keeled posteriorly; anal single; preoculars lacking; loreal enters eye, as do prefrontals. Probably most closely related to *annulifera* in general color pattern, in similarity of ventral and caudal counts and in general scalation. However, *malacodryas* differs from *annulifera* in having the posterior half of the body keeled and having narrow, transverse, light bands which do not

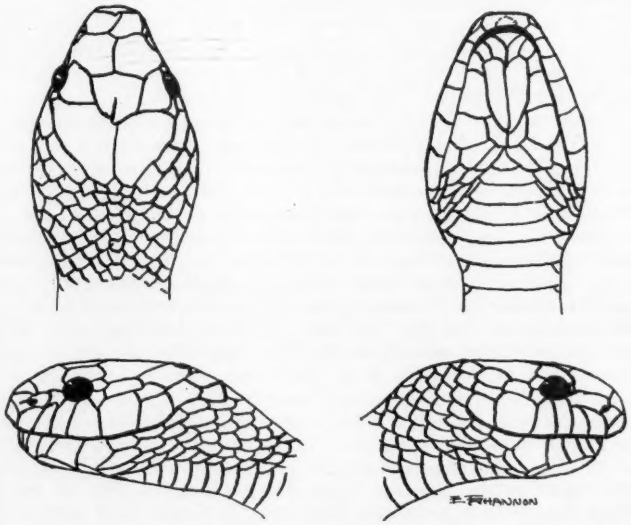

Fig. 1. *Tropidodipsas malacodryas, sp. nov.* Diagram of head scales.

*From the Greek meaning "gentle woodnymph."

widen laterally. In *annulifera* these bands widen abruptly on the sides, appearing like inverted funnels. The only other *Tropidodipsas* from Mexico having 15 rows and keels on the posterior half of the body is *philippi* from Mazatlán, Sinaloa, which is spotted and has two preoculars.

Description of holotype. Rostral large and curving with lateral edges angulating toward midline on labial border; crescentically concave immediately superior to mental. Internasals paired, irregularly shaped, about ¼ size of prefrontals; prefrontals paired, each equal in size to frontal, in broad contact with postnasals and loreals. Left prefrontal enters eye, whereas right is split off to form a small, azygous preocular; frontal with longitudinal on left posterior margin for slightly less than ½ length of scale; supraorbitals, 1-1, wider posteriorly; parietals, 1-1, large. Prenasals, 1-1, somewhat rectangular; left prenasal split for 2/3 its width, tending to form two scales one above the other; postnasals, 1-1, no loreals; no preoculars except for azygous portion of right prefrontal; postoculars, 2-2; temporals, 1+2; supralabials, 6—6, columnar, increasing in width posteriorly, 5th largest, 3rd and 4th entering eye.

Mental small, triangular, separated from anterior chinshields by symphyseal contact of first infralabials; infralabials, 8-9, four in contact with anterior chin shield on right, five on left; anterior chinshields long, slender, acuminate posteriorly, with the apex penetrating deeply between the posterior chinshields ¾ of their length; posterior chinshields small, with 4/5 of the common symphyseal border between anterior and posterior chinshields occupied by anterior shields.

Total length, 195 mm.; tail length, 96 mm.; % tail of total, 19.4; scales 15-15-15, weakly keeled over posterior half of body and especially pronounced on vertebral rows; keeling more widespread near tail; apical pits absent; ventrals, 143; anal single; caudals divided, 96.

The dorsal surfaces of the head black, excepting a small cream-colored spot on the third left supralabial. A transverse, cream nuchal band, two scales long, located just posterior to the tips of parietals, widens by invasion of 6th supralabial, to sweep out over the gular area, covering ventral surface of the head, excepting the black bordering the mouth of the first six infralabials. In addition to the nuchal band, there are 12 narrow, widely separated cream bands on a black body, and 6 on tail. Body bands are 1½ to 2 scales long in center of dorsum and do not perceptibly widen or narrow laterally, with the exception of the first body band which is 3 scales long on the first left row and 2½ on the first right. The bands widen on the ventral surfaces as they cross the belly, and the widened, first transverse band is adjacent to four cream-colored ventrals. Most of the light bands involve the greater portion of three ventrals. On both dorsal and ventral surfaces the light rings are invaded with black, giving those of the dorsal surface a dirty appearance concentrated around the borders. This black edging also occurs on the ventrals, which are additionally darkened by irregular black spots or blotches, with an overall gradual increase in pigmentation posteriorly. A similar band, confined to the venter, occurs between the nuchal and first ventral bands, and again between the 10th and 11th ventral bands. The broad, uniformly black dorsal interspaces or bands, as measured in length on the vertebral row, are approximately 16, 13, 13, 11, 10, 8, 8, 8, 10, 12, 12 and 11 rows long

respectively. The light caudal bands are uninterrupted across the under surface.

Considerable speculation preceded the decision to create a new species based on this individual. It was the first felt that the snake might represent a mainland record for or a new subspecies of *Exelencophis nelsoni* (Slevin),[1] described from María Madre Island, Tres Marías Islands. Unfortunately the holotype and only known specimen of *E. nelsoni* has since been lost in the mail. A case for subspeciation might be made on the basis of the high ventral and caudal count of the mainland snake (*nelsoni* having only 130 and 39 respectively), but *nelsoni* was described as having the mental in contact with the anterior chinshields, the nostril in a single nasal and the anterior chinshields only twice as long as the posterior. In addition, only three white bands were present on the tail. Subspeciation and pleomorphous scale development as demonstrated by the mainland snake may well account for these differences, but it was felt that too many variables were present to safely continue this line of investigation.

Tropidodipsas annulifera was described by Boulenger[2] as having 15 rows, 6 upper labials, 4 or 5 lower labials in contact with the anterior chinshields, a single loreal entering eye, no preoculars, a single anal plate and 20 white bands on the body (body and tail). The illustrations are suggestive of *malacodryas*. Although the ventral and caudal counts of the two males might be within population limitations, several other factors mitigate against recognition of the two as representatives of a single population. The holotype of *annulifera* clearly lacks keeling on any scales, as confirmed by J. C. Battersby (*fide* correspondence); has contact of the mental with the anterior chinshields, as contrasted to separation of these by the first infralabials in *malacodryas;* has polygonal, fairly large and distinct posterior chinshields, whereas those of *malacodryas* are smaller and are extensively overlapped by the anterior chinshields. The postnasal area of *annulifera* is light, that of *malacodryas,* black. In contrast to the narrow light bands of *malacodryas,* these bands in *annulifera* are not only wider initially, but widen laterally, and the extent of involvement of the ventral scutes in this lighter configuration is also greater. Thus in the data supplied by Mr. Battersby, two light bands are three scales long on the vertebral row and five on the ventral; six have two-four; three have two-three; one has two-four; and two have two-three on the body. In contrast to the extremely narrow bands on the tail of *malacodryas,* Battersby lists for *annulifera*: "2/3, 2/2, 2/3, and ?/?," the question marks indicating an area where the white is diffused with brown and not clearly marked. There thus seems to be little doubt as to *malacodryas* being distinct from *annulifera.* There is then the question of how distinct. If *annulifera* represented a population adjacent to or even reasonably disjunct from that of *malacodryas,* argument might be brought to bear on the subject of subspeciation. However, no locality data are available for *annulifera.* Amaral[3]

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[1] 1926. Proc. Calif. Acad. Sci., ser. 4, vol. 15, pp. 200-201.

[2] 1894. Cat. Snakes Brit. Mus., vol. 2, p. 297, pl. 14, fig. 1.

[3] 1929. Mem. Inst. Butantan, vol. 4, p. 193.

believes that annulifera should be restricted to Nicaragua and considered a junior synonym of *Dipsas* (=*Sibynomorphus*). For lack of more precise information, there appears to be little alternative to elevating *malacodryas* to specific rank.

In addition, of course, there appears to be doubt in at least one author's (Amaral's) mind concerning even the generic allocation of *annulifera*. From the low maxillary tooth count of *malacodryas* and from its seemingly close relationships to *Exelencophis*, more investigation toward the generic limits of *Tropidodipsas* appears to be in order before subspecific allocations are attempted. It is of interest to note that X-rays of the skull of the holotype of *malacodryas* reveal broad articulation of a straight pterygoid with the quadrate, a character noted by Smith and Taylor[4] to be consistent with *Tropidodipsas*.

A d.o.r. individual of *Tropidodipsas* was collected at 3:20 A.M. July 15, 1958, 63.5 mi. N Mazatlán, Sinaloa, on the Pacific Coast Highway. Intermittent light showers occurred during the night and helped reduce adhesion of the macerated and flattened snake to the pavement, as well as to prevent drying of the considerably increased surface area presented by the reptile. The snake represents an undescribed species of *Tropidodipsas* and is described from the single battered type specimen.

Tropidodipsas freiae, sp. nov.*

Holotype. FAS No. 13555♂ from 63.5 mi. N Mazatlán, Sinaloa, Mexico, collected by Frederick A. Shannon and Frances L. Humphrey July 15, 1958.

Diagnosis. Most closely related to *Tropidodipsas occidentalis* in general dorsal color pattern, in the number of scale rows, in general arrangement and number of head scales and in a large eye. Differs from *occiden-*

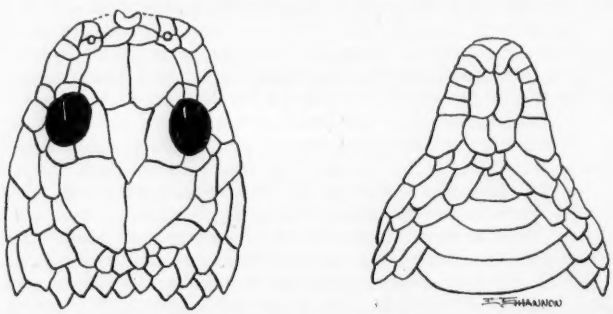

Fig. 2. *Tropidodipsas freiae, sp. nov.* Flattened diagram of head.

[4] 1945. Smithsonian Inst., U.S.N.M. Bull. No. 187, p. 49.

* From Freia, the Teutonic goddess of youth.

talis in extension of first 11 and the 13th white annuli completely across belly with a thin, irregular, midventral longitudinal line connecting the annuli; tail uniformly black ventrally contrasted to mottled white and black, occasionally interrupted by a white annulus on the ventral tail surface of *occidentalis*; dorsal white annuli narrower (1-1.5 scales long; 1.5-3 in *occidentalis*); nuchal white band narrower (1 scale long), situated 2 scales behind parietal, contrasted to wider band (2 scales long) situated directly behind the parietals of *occidentalis*; 3 preoculars, contrasted to 2 in *occidentalis* (perhaps variable); weakly keeled scales posteriorly; higher ventral count (200 in *freiae*; 175 in the holotype of *occidentalis*) in males.

Description of holotype. Rostral small, rounded superiorly, with central indentation inferiorly. Internasals paired, rounded anteriorly, about ½ length of prefrontals; prefrontals paired, each subequal in length to the frontal, in broad contact with postnasals and loreals. Frontal longer than wide, equal in length to distance from end to snout, 2/3 as long as parietals; supraorbitals 1-1, wider posteriorly; parietals large. Prenasals 1-1, almost square; postnasals 1-1; no loreals; preoculars 3-3; postoculars 2-2, upper one nearly twice size of lower; temporals 1+2; supralabials 8–7, 7th largest, 4th and 5th entering eye. Eye large, diameter equal to distance from eye to end of snout; twice the width of labial surface beneath the eye.

Mental small, triangular, separated from anterior chinshields by symphyseal contact of first infralabials; infralabials 8-8, 6 in contact with anterior chinshields; anterior chinshields long, rectangular; posterior chinshields 2/3 length of anterior chinshields, roughly rectangular. Gular surface strongly pustular, as is anterior half of belly, pustules decreasing in number over this area posteriorly to at least the 100th scale row. There is a tendency for the pustules to be arranged in transverse, roughly linear rows, especially concentrated on anterior surface of ventrals.

Total length, 533 mm.; tail 136 mm.; % tail of total, 25.5 (body length only approximate, tail length reasonably accurate). Scales in 15-15-13 rows, with scattered keeling over posterior half of body; apical pits absent; ventrals, 200; anal single; caudals divided, 77.

The dorsal surface of the head is black in alcohol. A transverse white nuchal band, 1 scale wide at middorsum, widens laterally to two scales and sweeps forward to cover the lower portion of the labials from the 5th posteriorly. The band extends ventrally to cover the gular region with the exception of the first five infralabials, which are dark. Dorsally there are 12 complete white bands on the body and six incomplete, with five on the tail. Mid-dorsally these body bands are one scale wide, widening laterally to 1½ or 2 scales. The first eleven and the thirteenth bands are continuous across the venter and all bands except the 18th are connected by a thin, irregular, white mid-ventral stripe. Most of the ventral annuli contain a central, irregularly-shaped dark spot, varying from one to four ventrals in width. The white markings on the tail are all one scale or less in width. The subcaudal surface is uniformly dark.

Maxillary teeth 11, progressing in size to the 5th and 6th which are the largest and diminishing in size posteriorly.

Remarks. Most closely related to *occidentalis* (Oliver: 1937[5]) in hav-

[5] Occ. Pap. Mus. Zoology, U. Mich., no. 360, pp. 20-22.

ing 15 rows, in general dorsal color pattern, in the large eye and in general arrangement and number of head scales; *freiae* differs in having the first 11 and the 13th annuli continuous across the belly, the annuli with central dark spots and being connected by a thin white longitudinal line; in having scattered keeling on posterior dorsum; in a higher ventral count (*freiae,* 200; *occidentalis,* 175); in having narrower dorsal white annuli (mid-dorsally: *freiae,* 1 scale wide; *occidentalis,* 1.5-3 scales wide); in having the white nuchal band narrower (1 scale wide) and situated two scales behind parietal as contrasted to *occidentalis,* in which the band is two scales wide and located directly behind the parietal; *freiae* also differs in having three preoculars (2 in *occidentalis*).

From the sympatric species *philippi, freiae* differs strikingly in total coloration, as the belly of *freiae* is essentially black, broken by white, whereas that of *philippi* is white with occasional dark spots. The dark dorsal bands of *philippi* are rounded and appear roughly similar to "spots," occasioned by drastic lateral widening of the white interspaces to merge with the white belly and cut off the dark dorsal areas in such a manner that the dark invades only the extreme lateral edges of the ventral scutes. The supralabials of *philippi* are 7-7; infralabials, 6-6 (perhaps variable?); anterior chinshields more than twice as long as posterior; loreals squarish contrasted to longer loreals of *freiae*; preoculars, 2-2 (variable?). Rostral width/length ratio nearly 3 in *freiae,* little more than one in *philippi.* Ventral count of *freiae* apparently considerably greater than that of *philippi.*

T. freiae may well represent a northern subspecies of *occidentalis,* but in the absence of further material the differences are so considerable that less taxonomic confusion may result by considering *freiae* a full species. In correcting the evils of too many species of earlier taxonomists, the subspecies ball has occasionally swung too far the other way.

Acknowledgements. We would like to thank Drs. Hobart M. Smith and David A. Langebartel for valuable advice on the relationships of *malacodryas;* also Mr. J. C. Battersby, who kindly sent us information on color and scalation of *annulifera.* Our thanks are due Mr. Joseph B. Dean, laboratory technician, for his excellent radiographs of the skull of the holotype of *malacodryas* and Ellen C. Shannon for the accompanying illustrations and for certain useful criticisms.

WICKENBURG, ARIZONA

OPHIDIAN NOTES.—A *Coluber constrictor foxi* from Mark Twain National Forest, Pulaski Co., Mo., laid 14 normal eggs July 16-17, 1959. For a week prior to laying, the female was very hostile to 3 like specimens in the cage, biting them if they touched her.

A *Storeria dekayi* from near Lake of the Ozarks bore 5 young Aug. 1, 1959. The female has the head and neck markings of the Texas subspecies, but the belly spots are of pinpoint size without any connecting lines.—*Capt. E. H. Ciochetti, Lawton, Okla.*

The Rediscovery of *Thamnophis praeocularis* (Bocourt) in British Honduras

By WILFRED T. NEILL AND ROSS ALLEN

Two snakes of the genus *Thamnophis* have been reported from British Honduras. One of these is the Central American ribbon snake, *T. sauritus chalceus* (Cope), whose presence in the country is well known. The other reported species has occasioned much debate, however.

Bocourt (1892:278) described *Eutaenia praeocularis,* type locality Belize. Ruthven (1908:7, footnote), in his review of the garter snakes, was unable to examine the type material of *praeocularis,* or to allocate the name. Schmidt (1941:498) noted that *E. praeocularis* probably was not identical with Cope's (1885:388) *E. rutiloris,* a ribbon snake from Cozumel Island off the coast of Quintana Roo, Mexico; but that it might be identical with Andrews' (1937:357-358) *Thamnophis arabdotus* from Catmis, Quintana Roo. Smith (1942:97) recognized *praeocularis* as a subspecies of *T. sumichrasti,* with *arabdotus,* a synonym thereof. Specimens available to Smith, and identified by him as *T. sumichrasti praeocularis,* included the type of *arabdotus,* and two examples from "Puerto Morelos, Yucatán" (*ibid.*:111). Presumably this locality actually is Puerto de Morelos, Quintana Roo. Bogert and Oliver (1945:358) considered *T. sumichrasti* to be conspecific with what was then called *T. eques.* As the latter name was older, *praeocularis,* if recognizable, would have stood as a subspecies of *T. eques.* Smith (1951:138-140) then pointed out that the name *eques* had been misapplied; the garter snake previously known as *T. eques* was properly to be called *T. cyrtopsis.* Smith did not follow Bogert and Oliver in considering this species to be conspecific with *sumichrasti.* For those who did so follow, *praeocularis* presumably became a subspecies of *T. cyrtopsis.* Milstead (1953) studied geographic variation in the species *T. cyrtopsis,* which he took to include *T. sumichrasti.* However, he did not recognize *T. s. praeocularis* (Bocourt), *T. s. fulvus* (Bocourt) from the Guatemalan highlands, *T. s. cerebrosus* Smith (1942:111-112) from the Pacific slope of Guatemala, or *T. s. salvini* Smith, Nixon and Smith (1950:579-580) from the Atlantic foothills of Guatemala. Milstead lumped all of these as *T. cyrtopsis sumichrasti,* with which he also synonymized *T. arabdotus* Andrews, *T. rozellae* Smith (1940:56-57) from Palenque, Chiapas, Mexico, and *T. bovallii* Dunn (1940:191-192) from Granada, Nicaragua. Milstead (*op. cit.*:360) also disavowed the Belize record, on the grounds that the species *T. cyrtopsis* did not occur below 1000 feet in Central America. On these same grounds he challenged the Escuintla, Guatemala, record of *T. s. cerebrosus,* the Puerto de Morelos record of *T. s. praeocularis,* and the Catmis record of *T. arabdotus.* Thus, after many nomenclatorial vicissitudes, Bocourt's *Eutaenia praeocularis* apparently vanished into oblivion.

Smith (1942: 98-99, 110) had also considered *rozellae* and *bovallii* to be synonyms of typical *sumichrasti.* However, Shreve and Gans (1958) presented evidence that *Thamnophis bovallii* was a distinct species, known from three lowland localities: Granada and San Jorge in Nicaragua, and the Boca do Rio Colorado on the Caribbean coast of Costa Rica. On April

11, 1959, we collected in British Honduras a garter snake whose characters suggested *T. bovallii*, but departed therefrom in the direction of *T. praeocularis* as described by Bocourt. This find reopens the problem of *praeocularis*' status.

Our specimen was taken in Belize District, British Honduras, beside the Cayo-Belize Highway, at a point about 200 yards west of the 32nd milepost from Belize. This locality is approximately 24 miles west and 11.5 miles south of Belize, the capital city (to state directions in terms of the cardinal points of the compass, as recommended by Riemer, 1954: 139). The altitude is less than 200 feet, the local plant association a savanna with pines, palms, palmettoes, and low thickets, as well as a gully and a few pond basins which were mostly dry at this season. The snake was bulldozed from clay soil in a roadside thicket.

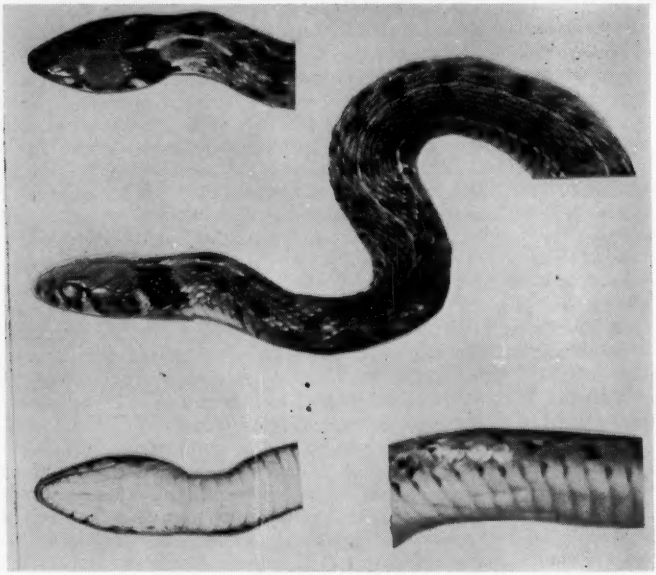

Fig. 1. *Thamnophis praeocularis* (Bocourt); 24.0 miles west and 11.5 miles south of Belize, Belize District, British Honduras; April 11, 1959. Compare with Pl. 56, fig. 7 in Duméril and Bocourt, 1897, *Mission Scientifique au Mexique et dans L'Amérique Centrale, Troisième Partie: Etudes sur les Reptiles et les Batraciens.*

The specimen (ERA-WTN No. BH-201 in our British Honduras collection) agrees, at least well enough, with *Thamnophis bovallii* in the following characters: Scale rows 21 at the neck; ventrals 146 (a female); subcaudals 68; tail about 24% of total length, a strong pattern on nape and sides of head; two rows of spots in the vertebral region; short lateral bars; size small, total length about 360 mm. Some other characters sug-

gest *praeocularis*: a narrow dorsal light stripe; nuchal band black; each ventral plate with two small spots on the anterior edge. The preocular is single on each side, but it is very large, bending abruptly over the canthus and onto the top of the head. One might say that the preocular has two parts: a vertical portion on the side of the head, and a horizontal portion atop the head. Furthermore, a faint groove incipiently divides the vertical portion into a larger upper component, and a smaller lower component just behind the loreal. Thus the preocular, while single, suggests the tripartite condition which Bocourt found in at least one of his two Belize examples.

Certain of the aforesaid characters merit brief discussion. The scales on the nape are tiny, crowded, and somewhat irregular; it would not be surprising to find other specimens which, like Bocourt's, had only 19 scale rows anteriorly. The dorsal light stripe occupies only one scale row, and becomes indistinct posteriorly. There is an interrupted, poorly defined lateral stripe, on the third scale row only. With some discoloration in preservative, all stripes would probably vanish. On each of about 8 ventral plates, in the mid-region of the body, there is a vague line of dark stippling along the anterior border, connecting the dark spots of opposite sides. An intensification of this stippling would result in a *bovallii* ventral pattern. The elaborate head pattern of our specimen is much like that of *bovallii*.

There now appears to be no reason to question various garter snake records just because they are for lowland areas. Bocourt's specimens, reported as from Belize, were taken by the French *Mission Scientifique au Mexique*, which touched British Honduras only at this city (Dunn and Stuart, 1951: 59); and Bocourt himself led the expedition. The record is therefore apt to be correct; and it is confirmed by our specimen, which is almost surely *praeocularis*, and which was taken only about 26.5 airline miles from Belize. The savanna area, in which the snake was found, extends with only minor interruptions to within 5 miles of Belize.

Furthermore, the characters of these small garter snakes seem to form north-south clines along the Caribbean drainage, as though there were a lowland species or complex apart from the upland *cyrtopsis* group. Thus in Quintana Roo (specimens from Catmis and Puerto de Morelos), the dorsal light stripe is broad; there are two dark spots on the anterior border of each ventral plate; the scale rows are 19 on the nape. Farther south, in British Honduras (Bocourt's specimens and ours), the dorsal light stripe is narrow, and indistinct posteriorly; on a few ventral plates the two dark spots are connected by dark stippling; there may be either 19 or 21 scale rows on the nape. Still farther south, in the San Juan drainage of Nicaragua and Costa Rica (specimens of *bovallii*), the dorsal light stripe is lacking completely; on most ventral plates the two dark spots are connected by a dark bar; there are 21 scale rows on the nape. There may also be a cline in the color of the top of the head, which is blackish (like the nuchal band) in Quintana Roo examples, dark olive-brown in our British Honduras specimen, still lighter in *bovallii* (and in *cerebrosus* Smith from the Pacific lowlands of Guatemala).

Of course, specimens are too few to insist upon the reality of these apparent clines. At any rate, we feel that the garter snake of British Honduras is a distinct species, to be called *Thamnophis praeocularis* (Bocourt).

The Quintana Roo population is very closely related and for the present need not be given separate taxonomic recognition. The population of the San Juan drainage is also related, but may provisionally be retained as a full species, *T. bovallii* Dunn. (This name is now generally amended to *T. bovalli*; it was intended to honor a Dr. Bovallius.) The description of *T. sumichrasti cerebrosus* Smith (1942: 111) strongly suggests an ally of *praeocularis*. From a biogeographic standpoint it would not be disturbing to find the *praeocularis* group at scattered localities on both Caribbean and Pacific lowlands; witness the erratic distribution of the *Bothrops lansbergi* group (Schmidt, *op. cit.*: 509; Smith, 1941: 62-63) or of *Elaphe flavirufa* subspecies (Dowling, 1952). But much more collecting must be done before it is possible adequately to define the *praeocularis* group, its components, and its relationship to the upland *T. cyrtopsis sumichrasti*. Andrews (*op. cit.*: 358) thought his *arabdotus* was related to *T. phenax*, and the notion is worth exploring.

In our British Honduras specimen of *Thamnophis praeocularis*, the peritoneum was densely pigmented and blackish. In an example of *T. crytopsis ocellata*, collected by the senior author about 10 miles west of Austin, Travis County, Texas, the peritoneum was unpigmented. The nature of the peritoneal pigmentation may in the future prove to be of considerable taxonomic value.

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RESEARCH DIVISION, ROSS ALLEN'S REPTILE INSTITUTE, INC.,
SILVER SPRINGS, FLORIDA

Doubtful Locality Records in British Honduras

By Ross Allen and Wilfred T. Neill

During the course of studies on the British Honduras herpetofauna, we were impressed by a number of locality records which seemed doubtful, or which needed reevaluation in the light of present knowledge.

Many of these questionable records result from a failure to distinguish between Belize as a name for the present capital city of British Honduras, and Belize as a name for the entire country or general region. Some workers, such as Dunn and Stuart (1951) or Smith and Taylor (1950a) have made such a distinction; but Schmidt (1941) did not do so in his important British Honduras checklist, and several other literature references are ambiguous.

The history of the colony has been detailed by Anderson (1958) and Caiger (1951). The present capital city seemingly had its start in 1638, when a group of shipwrecked logwood cutters built huts near the mouth of Old River (Belize River). The settlement was enlarged a few years later by a Scotch buccaneer, whose name appears in the early archives as Wallace, Willis, Valvs, Bullys, Bellise, Belice, or Belize. In its last form the name was applied to the community at the river mouth, and eventually to a good bit of the surrounding country. The boundaries of Belize, as a country, were but vaguely defined in earlier times. Not until 1840 was any attempt made to distinguish nomenclaturally between the city proper and the country as a whole; and it was not until 1862 that the latter was officially dubbed British Honduras. This usage was slow to find general acceptance, and it has never been adopted by Latin Americans to any extent. Guatemaltecans, especially, have been reluctant to abandon the older name for the region. British Honduras has been populated to a large degree by people coming from Guatemala and Mexico, so that even today, outside the capital city, the entire country is often referred to as Belize.*

A majority of the amphibians and reptiles of British Honduras were first collected, studied, or described between 1830 and 1890. Specimens taken during this period (as well as some collected later), and labelled "Belize," may truly have come from what is now the capital city, or alternately may have come from some point far away, perhaps even outside the present boundaries of British Honduras (as on the headwaters of the Belize River). Quite a few early records, given simply as Belize, now appear in the literature as "Belize, British Honduras," perhaps falsely implying capital city provenience. And there is a probability that this city, like Cobán in Guatemala and Colima in Mexico, was for some specimens a shipping point rather than a collecting station.

Smith (1939) included British Honduras, Petén, Yucatán, and Quintana Roo in a single biotic area, the Petén Province. Schmidt (*op. cit.*: 479-480) expected further collecting to show that the herpetofauna of British Honduras was much like that of the Guatemalan department of Petén, in spite of the fact that his respective lists were quite different. However, from an ecological standpoint British Honduras is not especially homogeneous. North of the latitude of the capital city, the country is mostly level or gently rolling, while to the south of this latitude it rises abruptly to Big Pine Ridge, the Maya Mountains, and the Cockscomb Range (highest point 3681 feet). Mean annual rainfall varies from about 48 inches at Corozal in the north, to about 150 inches at Punta Gorda in the south (Anderson, *op. cit.*: 11). Many species, particularly those of the drier and more open habitats, probably reach British Honduras only in the north, while some others, characteristic only of dense rainforest, are likely to be present only in the south. The tip of the Yucatán Peninsula—an important area of endemism—is quite different from the basal portion, and the faunal transition is accomplished in part through British Honduras. The *minutiae* of distribution in the latter country therefore take on a larger significance.

Furthermore, there exists, with reference to Belize, a situation virtually unique in taxonomy. This city is supposedly the type locality in the case of at least 12 scientific names involving 11 reptile species. However, most of these species are not represented in museum collections by Belize specimens with unequivocal collecting data, and so are not definitely known to occur at their presumed type locality. Clearly there is a need for further consideration of herpetofaunal distribution in British Honduras.

The city of Belize is located at the tip of a peninsula. The peninsula, about 24 square miles in extent, lies at an elevation of less than 24 inches. Its natural cover was almost entirely a salt or brackish water association, mangrove swamp. The herpetofauna of Belize consists of species that can live in mangrove swamp, or else about yards, gardens, buildings, and the like. Ecological considerations, plus recently collected specimens, permit interpretation of some earlier "Belize" records.

There follows a list of the British Honduras records that merit reanalysis.

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*In our usage Belize refers to the capital city only. Distances are measured from the nearest boundary of Belize, employing maps GSGS 4767, Sheets 1-3, Edition 1. Directions are stated in terms of the cardinal points of the compass, as recommended by Riemer (1954).

Agkistrodon bilineatus bilineatus Günther. Schmidt (*op. cit.*: 508) listed a British Museum specimen from "Belize," collected by Sclater. The same example was probably the basis for Günther's (1902: 186) "Belize" record of the species. Schmidt also listed a Chicago Natural History Museum specimen from "British Honduras," without more precise data; it was originally in the remnant of a large collection amassed by a missionary, W. A. Stanton. But Burger and Robertson (1951: 216) listed this same example as though definitely from the capital city; and Gloyd and Conant's (1943: map 2) spot map for the cantil included a symbol at Belize, probably based on Stanton's snake. Charles L. Payne, professional guide and a widely traveled resident of British Honduras, told us he had never encountered the snake in this country. Anthony Wolffsohn, of the British Honduras Forestry Department, and a collector of snakes, had not seen it, and believed that it must be restricted to the northern part of the country if present at all. This is also our view, based on a knowledge of the cantil's habitat in Mexico. It might occur around, say, Chan Chen in Corozal District, but scarcely in the Belize area where no one knows it. It has not been reported in Quintana Roo or on the Atlantic slope of Guatemala.

Dryadophis boddaerti (Sentzen). Sanderson (1941: 167) mentioned the collection of this species in British Honduras. Ordinarily, little attention would be paid to a record of this kind. However, the present case is noteworthy because Schmidt (*op cit.*: 478) stated that he supplied the herpetofaunal identifications in Sanderson's book. In Schmidt's checklist (*ibid.*: 499) the snake is properly identified as *D. melanolomus*, the only species of the genus to occur in British Honduras.

In like fashion Sanderson described the collection (in trees) of a British Honduras mud turtle, genus *Kinosternon*; and in an accompanying, unnumbered plate (*op. cit.*: between pp. 92 and 93) its identity was given as *K. creaseri*. However, in his checklist Schmidt (*op. cit.*: 488) correctly identified Sanderson's mud turtles as *K. leucostomum* and *K. c. cruentatum*. It may be mentioned in passing that Sanderson's vernacular name for his mud turtles actually relates to *Pseudemys scripta ornata*, and his vernacular name for the latter (p. 239) really pertains to *Dermatemys mawei*. Thus there is some question about the identity of Sanderson's arboreal turtles.

Elaphe triaspis triaspis (Cope).—The type specimen was from "Belize," collected by Parsons (Cope, 1866: 128). Smith and Taylor (1950b: 316) restricted the type locality to the city. Dowling (1952: 7) accepted the restriction on the grounds that Parsons visited British Honduras only at Belize. It is true that some of the Parsons collection was from "Belize," but this may have had reference to the whole country and not necessarily to the city; indeed, the country had no other name than Belize when Parsons was collecting. It will be recalled that the same collection included a caecilian which Cope (*op. cit.*: 129) named *Siphonops syntremus*. The unique type of *syntremus* was lost, and Dunn (1942), in his review of American caecilians, was unable to allocate the name from Cope's description. Dunn (*op cit.*: 540) pointed out that the U. S. National Museum, which contains the Parsons collection, had a specimen of the (South American) *Typhlonectes compressicauda natans* labelled "Belize," and that this may have been the type of *syntremus*.

Another possibility was that the type of *syntremus,* minus its original data, later served as the type of *Gymnopis oligozona,* a species confined to Alta Verapaz, Guatemala, so far as is known (*ibid.*: 470, 540). Parsons also sent various specimens from Honduras, and indeed the puzzling caecilian was originally listed as Honduranean. Later, however, Cope (1885: 171) listed the type of *syntremus* as from "Belize." No caecilian has since been taken in British Honduras. The vicissitudes of *syntremus* have a bearing on the supposed provenience of Cope's *Elaphe triaspis,* for they show that one cannot unreservedly accept Cope's version of Parson's collecting data. Furthermore, in his original description of *E. triaspis,* Cope presented some observations, apparently by Parsons, on the size, activity, abundance, and vernacular name of this snake; but the remarks clearly pertain to *Spilotes pullatus mexicanus.* Thus there is further evidence of confusion. No other example of *E. triaspis* has since been found at Belize or any other locality in British Honduras.

Whatever taxonomists choose to do about the "Belize" type locality, we feel that herpetogeographers would do well to ignore the record until it is verified by specimens with unequivocal collecting data.

Lachesis muta stenophrys Cope.—No herpetological paper has ascribed the bushmaster to British Honduras, but in the best known guidebook to the country it is said to be present although rare (Anderson, *op. cit.*: 88). While it just might possibly occur, we doubt the record. Ditmars (1937: 132) suggested that reports of the bushmaster, north of its known range, might be based on the jumping viper, *Bothrops nummifera,* which somewhatly resembles the larger species in coloration and rough scalation. The northernmost record of the bushmaster appears to be in Nicaragua.

Dermatemys mawei Gray.—A specimen of this turtle, taken somewhere in the Belize River, served as the type of *D. abnormis* Cope (1868: 120). The river arises in Petén, Guatemala, where the species has definitely been reported, and flows through British Honduras to reach the Caribbean at Belize. Knowledge of this species in British Honduras is based mostly on Stanton's specimens without definite locality data (Schmidt, *op. cit.*: 487) and the early "Belize" records of Bocourt, Cope, and de Borre, summarized by Günther (*op. cit.*: 10). Smith and Taylor (1950b) restricted the type locality of *abnormis* to the city of Belize. Dunn and Stuart (*op. cit.*: 59) objected to the restriction on the grounds that the turtle probably did not reach the salt or brackish portion of the river in the vicinity of the town.

This is a water turtle, occurring in a variety of aquatic situations but being most characteristic (at least in British Honduras) of large streams. Freshwater turtles of several families will invade salt water occasionally if not frequently (Neill, 1958: 12-27), and *Dermatemys mawei* may now be added to the list. At hand is a carapace of this species with attached barnacles, betokening long residence in salt water. It was obtained from a local resident at the junction of Roaring Creek and the Belize-Benque Viejo road, but probably was originally collected elsewhere. Thus a Belize type locality for *D. abnormis* is geographically and ecologically acceptable.

Malaclemys species.—Holbrook (1842: 87-91) thought that the diamondback terrapins ranged to South America. Gray (1855: 37) recognized five varieties of "*Malaclemmys concentrica,* salt-water terrapin."

One of these, "Var. 5 *areolata,*" was from Petén, Guatemala. Agassiz (1857: 437, footnote) accepted the record and likewise believed that the genus reached South America. Hay (1904: 4), in his revision of the diamondback terrapins, remarked, ". . . the record [for Petén] is of interest in that it shows that the genus extends to the neighborhood of Yucatan." Even today it is customary to state that diamondback terrapins, while not definitely known to range farther south than Texas, may well reach the Yucatán Peninsula. This statement, which appears in the literature in many places, apparently stems from the writings of Hay, Gray, etc. Of course, the "variety *areolata*" from Petén is the turtle now called *Geoemyda areolata* (Duméril and Bibron), a terrestrial species superficially resembling a *Malaclemys*. Some workers (*e. g.,* Carr, 1952: 184) have been aware of this, but the actual situation merits reemphasis. A population of the diamondback terrapin has not been found on the coast of Mexico, British Honduras, Guatemala, or countries farther south.

We may now briefly discuss "Belize" as a type locality for several more reptile names.

The type locality of *Anolis ustus* Cope is Belize, generally interpreted to mean the city. Three Stanton specimens bear the additional data "Belize (North River)," according to Schmidt (*op. cit.*: 493); this presumably means the more northerly delta mouth of the Belize River, although there is a Northern River elsewhere in the country. In April, 1959, we collected this lizard near the Belize-Maskalls road, at a point about 12 miles west and 11 miles north of Belize, in Belize District; and along the Belize River at Succoths (Succotz), Cayo District. The lizard appears to be one of brushy and grassy places, especially near water, and is probably independent of some major plant association boundaries. We see no ecological reason for rejecting the Belize records of this species. The city is also an acceptable type locality for *Tretanorhinus nigroluteus lateralis* Bocourt, both from an ecological standpoint and on the strength of the original description. It is likewise acceptable for *Thamnophis praeocularis* (Bocourt), whose rediscovery we announce elsewhere in this journal. An account of our British Honduras collections, now in press, reports *Spilotes pullatus mexicanus* (Laurenti) in mangrove swamp at Belize, so that one need have no doubt concerning the provenience of *Herpetodryas incertus* Jan, a synonym. It is hard to believe that *Ninia s. sebae* (Duméril, Bibron, and Duméril) ever thrived in the Belize mangrove swamp, but it is now abundant in gardens and vacant lots of the city; thus one might accept Belize as a type locality of the synonym *Streptophorus sebae dorsalis* Bocourt. If *Alligator lacordairei* de Borre is a synonym of *Crocodylus moreleti* Duméril and Duméril, it could well have come from the immediate vicinity of the city, where the species was once common.

The presence of *Micrurus affinis alienus* (Werner) at Belize is less certain. Specimens now with a "Belize" label were all taken long ago, when the name signified the entire country. Some of them were from the remnant of the old Stanton collection. Of course missionaries with biological interests are apt to receive specimens taken far afield; and in Stanton's day the value of precise locality data was not appreciated. We are therefore dubious of a Belize type locality for *M. a. alienus* and its synonym, *M. a. stantoni* Schmidt. It is true that the species has been taken on the British Honduras coast at Stann Creek, but the ecological situation

there is quite different from that which obtains at Belize. At Stann Creek there is but a narrow, broken mangrove belt, and the forest closely approached the sea as evidenced by relict trees and patches of timber. *M. a. alienus* is a snake of the forest, and is not to be expected in mangrove swamp.

The case of *Leptodeira septentrionalis polysticta* Günther is also troublesome. Duellman (1958: 72), in his review of the genus, stated that the type locality of *polysticta* was restricted to Belize by Smith and Taylor in their 1950 paper (1950b: 316). The actual restriction was earlier (Smith and Taylor, 1945: 87). By this action an old "Belize" specimen, collected by Godman, became the lectotype. This specimen was also the basis for Schmidt's (*op. cit.*: 505) single "Belize" record. The locality datum probably referred to the country as a whole. *L. s. polysticta* is a snake of the broadleaf forest, often living in bromeliads and feeding on treefrogs, *Phyllomedusa* eggs, and anoles as well as the small frogs and lizards of the forest floor; it is not to be expected at the capital city or on the Belize peninsula.

Several other "Belize" and British Honduras records merit discussion, but we have no new information bearing on them.

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RESEARCH DIVISION, ROSS ALLEN'S REPTILE INSTITUTE, INC., SILVER SPRINGS, FLORIDA

ALBINISM IN *THAMNOPHIS SAURITUS*.—On August 13, 1958, an albino Ribbon Snake, *Thamnophis sauritus proximus* (Say), was collected by Robert Donnellen in Waco, McLennon County, Texas. It measured 42 cm. t-l. Its dorsal color was pure white with the exception of the dorsal and lateral stripes which were buff. The eyes, tongue, and ventral surface were pink—the tongue being the darkest and the venter lightest. It was active and fed readily on small fishes. No physical abnormalities were in evidence. The specimen has been deposited in the Museum of Zoology, University of Michigan.—*Francis L. Rose, University of Georgia, Athens, Georgia.*

METHODS OF EATING AND GENERAL BEHAVIOR IN SOME OLD WORLD SAURIANS IN CAPTIVITY.—I recently received a shipment of Saurians from Tel-Aviv, Israel, including two *Agama stellio,* which are relatively common. It is apparent that they are active during daylight and hide under rocks or logs at night. Their cage is equipped with a sixty watt light bulb, in an aluminum reflector, under which they warm themselves. When food, usually Insecta, is placed in the cage they do not pursue it, but ambush it, securing it at midbody, slightly masticating and ingesting it. They have never been observed drinking, therefore it is assumed that they obtain their water from the food.

A juvenile *Mabuya vittata,* also from near Tel-Aviv, is relatively active during the day and is usually found sunning directly under the heat. During the cool of the night, it is found buried in the coarse gravel in the warmest section of the cage. This change of position generally occurs during the first twenty minutes after or before the light is turned on or off. The tongue is applied to the prey for identification. After the prey, Insecta, has been identified, it is attacked at midbody and masticated; then ingested anterior section first. It is probable that it obtains water from desert plants in the early hours. This assumption is based on the fact that it drinks from a dropper and has never been observed drinking from a dish.

Acanthodactylus sculellatus, a juvenile from Tel-Aviv, is generally active during daylight although it has never been observed to sun itself. It buries under the largest rock in the coolest section of the cage during the night and reappears after the sixty watt light has been turned on. The tongue is employed for the identification of prey much as in *Mabuya.* The prey, Insecta, is pursued and attacked, then ingested in any fashion. It has been observed to drink from a dish, but also takes small drops of water on the gravel.

A *Crodylus crodylus niger* from Capetown, South Africa, is often found sunning in a position similar to that employed by *Phrynosoma* while the seventy-five watt spotlight is on; but retreats to its rock cavity during the cool of night. The tongue is used as a "Feeler." The food, consisting of Insecta, Lumbricus and small Saurians is pursued, and attacked in the same manner employed by *Phrynosoma.* The food has often been taken off the forceps and the water is taken either from a dropper or from a dish. The actual ingesting is a voracious procedure, the prey being thrashed about several times and consumed in any fashion.—*Stephen D. Busack, 8 Riverview Heights, Rochester 23, New York.*

A SIZE RECORD FOR GRAHAM'S WATER SNAKE.—On June 5, 1958, a female *Natrix grahami* Baird and Girard was collected as it emerged from a crayfish hole at Dry Walnut Creek, .3 mile north of Great Bend, Barton Co., Kansas. The specimen (KU 51446) was 33½ inches long immediately after death. The length of the KU specimen exceeds by 4 inches the previous record of 29½ inches (Strecker, 1926, Contrib. Baylor Univ. Mus., No. 4). The snake contained 25 embryos; Schmidt and Davis (1941, Field Book of Snakes of the U. S. and Can.) reported that 10 to 15 embryos was the normal number.—*Robert N. Miner, 2824 Paseo Dr., Great Bend, Kansas.*

Additions to the British Honduras Herpetofaunal List

By WILFRED T. NEILL and ROSS ALLEN

Schmidt (1941) summarized what was then known of herpetofaunal distribution in British Honduras. We visited this country in April, 1959, taking several species not hitherto reported in the region. Some of these are discussed herein. Specimens are in our preserved collection.

Phrynohyas spilomma (Cope). The name *Hyla venulosa* (Laurenti) was long applied to a group of treefrogs characterized by (among other things) lateral vocal sacs and a very toxic skin secretion. Taylor (1934) showed that these frogs were generically distinct from *Hyla,* and that the Mexican populations thereof were a composite of at least three species. For these Taylor employed the generic name *Acrodytes* Fitzinger. Later, Taylor (1952: 799) suggested that the name *Phrynohyas* might take precedence over *Acrodytes.* Duellman (1956a) pointed out that *Acrodytes* is *nomen dubium,* its type species being unidentifiable. Duellman (1956b) also petitioned the International Commission on Zoological Nomenclature to suppress the specific name *venulosa* and the generic name *Acrodytes.* Thus the oldest acceptable name for the genus appears to be *Phrynohyas* Fitzinger; and the British Honduras species agrees well enough with *P. spilomma* (Cope) as redefined by Duellman (1956a: 29-33).

This widely ranging frog has been taken in Petén, Guatemala (Stuart, 1935: 39, as *Hyla venulosa*) and in Yucatán, Mexico (Smith and Taylor, 1948: 75, as *Acrodytes spilomma*); thus its presence in British Honduras is not surprising. On April 7, 1959, one specimen was found at a locality in Belize District, about 18 airline miles west and 5.5 miles south of Belize (city), a few hundred yards north of the Belize-Cayo highway and near its junction with the Gracy Rock turnoff.[1] On April 10 a specimen was collected near the Belize-Maskalls highway at a point about 12 miles west and 11 miles north of Belize, Belize District; and six more at Maskalls on Northern River, Belize District, about 26.5 miles north and 8 miles west of Belize.

In living examples from British Honduras, the head is light greenish-brown (16 H 10 in the terminology of Maerz and Paul, 1950) with small, irregular spots of darker brown. There is a single dorsal band of dark brown (darker than 16 A 12), bordered laterally by a flax (12 B 2) stripe. This light stripe fuses with its fellow across the posterior portion of the body, thus terminating the dorsal dark band in advance of the sacral region. The dorsal band is darker at its borders than along the midline of the back. With a little fading in preservative, the lighter central portion of the dorsal band would probably blend with the ground color of the head, leaving the darker edges to appear as longitudinal stripes. (Taylor, 1934: 64, and Smith and Taylor, *op. cit.*: 74, considered two dark dorsal stripes to be a key character of the species.) The limb bands are

[1] British Honduras will probably develop industrially in the near future, with resultant changes in roads, place names, and the boundaries of communities. Consequently we have described collecting localities in terms of several reference points. Directions are stated in terms of the cardinal points of the compass, as recommended by Riemer (1954: 139). Distances are from the nearest boundary of Belize (city), as shown on War Office maps GSGS 4767, Sheets 1-3, edition 1.

the color of the dorsal band, mottled with and outlined by a darker brown. The ground color of the limbs is light, about like the dorsolateral light stripes.

The frog taken near Gracy Rock was in a water-retaining bromeliad which grew about 5 feet off the ground in a small tree. The tree, bedecked with several species of bromeliads, and with shower-of-gold orchid (Oncidium), was one of a number growing in small pond basins. The basins, dry at this season, were set in relatively open country with scattered palms, palmettoes, pines, and scrubby thickets. At the second locality mentioned above, the country was open and savanna-like, but with scattered trees and copses suggesting deforestation by man. A nearby pond held water. The Maskalls frogs were in large metal drums, used as cisterns by the local residents. The drums, nearly full with rusty water from the housetops, had been loosely covered. The villagers called our attention to these frogs, which they called "spring chickens."

Thecadactylus rapicaudus (Houttuyn). Schmidt (*op. cit.*) omitted this gecko from his British Honduras checklist. We did not encounter it, but Günther (1902: 81) reported it from this country. As it has been collected at Felipe Carillo Puerto in Quintana Roo, Mexico, about 85 miles north of British Honduras (Peters, 1953: 231), and at Flores in Lago Petén Itzá, Petén, Guatemala, about 45 miles west of British Honduras (Stuart, 1934: 8), as well as in Honduras to the south (Schmidt and Inger, 1957: 73), there seems no reason to doubt Günther's record even though an exact locality was not given.

Yucatán records of this species are mostly for caves (Gaige, 1938: 297; Smith and Taylor, 1950: 49), of which there are many in British Honduras. The Felipe Carillo Puerto area supports rainforest with sapodilla, mahogany, "cedar" (Cedrela), ceiba, etc. (Peters, *op. cit.*: 227); this same sort of forest is widespread in British Honduras. Ecological considerations therefore do not militate against acceptance of Günther's record.

Cnemidophorus gularis Baird and Girard. On April 6, 1959, we saw four racerunners at Stanley Airport, about 7.5 miles west and 2 miles north of Belize, Belize District. In size, color, and behavior they were reminiscent of the North American *C. sexlineatus*. We caught no specimen at the airport. On April 7 we found another population of these lizards at the aforesaid locality near Gracy Rock, where we also took *Phrynohyas spilomma*. Here one racerunner was collected, and the tail of another; a third individual escaped intact.

The collected specimen is a member of the *sexlineatus* group. By Burt's (1931) arrangement it would be *Cnemidophorus sexlineatus gularis*. However, *C. sexlineatus* does not intergrade with *gularis* (Taylor, 1936: 520-521). By Smith and Taylor's (1950: 180-185) arrangement the British Honduras racerunner would be some subspecies of *C. sacki*. But Zweifel (1959) showed that, in western Mexico alone, the *C. sacki* of authors is a composite of at least three species, and suggested (p. 71) that other distinct species were currently lumped with *sacki*. Our lizard is specifically, and probably subspecifically, identical with the common savanna racerunner of Petén, Guatemala. Schmidt (*op. cit.*: 480) and Stuart (1935: 47) have called this form *C. gularis*, and for simplicity we have followed this usage. Until the Central American members of the *sex-*

lineatus group are studied intensively, the correct name for the British Honduras racerunner must remain in doubt.

The racerunners that escaped were plainly seen. They were strongly lined, and showed little or no trace of fading or of pronounced spotting. The lizard collected had a slightly faded vertebral streak or band of dull brown, but was otherwise distinctly striped. The throat, chest, and abdomen were completely black. All the racerunners seen, at both localities, were about equal in size to average adults of *Cnemidophorus sexlineatus*. Davis and Smith (1952: 97), studying lizards of the *C. sacki* complex in southern Mexico, noted that large adults were not to be found during the winter months. A comparable situation might exist in British Honduras. However, a completely black venter seems to develop only in fully adult specimens (Zweifel, *op. cit.*: 68), and we suspect that the British Honduras lizards are not members of the "giant" group which includes *C. communis, C. gigas,* and several forms currently placed as subspecies of *C. sacki*.

At the airport the racerunners were in an open spot with much bare ground, scattered patches of low grass, and some planted shrubs. Near Gracy Rock they were found in open country with somewhat more grass and a scattering of pine stumps. Both areas had been altered considerably by man's activities.

Crotalus durissus tzabcan Klauber. Günther (*op. cit.*: 194, as *C. horridus*) reported the Neotropical rattlesnake from British Honduras, without more precise data. Schmidt (*op. cit.*) and Gloyd (1940: 480) gave no indication that the species ranged into this country. Klauber (1952: 73), in his description of *C. d. tzabcan* from the northern part of the Yucatán Peninsula, mentioned that the species did occur in British Honduras, but he did not suggest which subspecies might be found there. Klauber (1956: 34) noted that *tzabcan* might range into the colony; actual specimens therefrom were lacking, however.

On April 11, 1959, Anthony Wolffsohn, Assistant Conservator of Forests in British Honduras, presented us with a living rattlesnake which he had caught a few days before near Augustine, in the Mountain Pine Ridge area of Cayo District. Mr. Wolffsohn said the species was not uncommon in this vicinity. The locality is about 53 miles west and 35 miles south of Belize.

The snake, a male, has 183 ventrals and 31 subcaudals. There are 15 supralabials; infralabials 17, the first divided. Scale rows number 27 at midbody. The ground color is, in the freshly shed example, grayish-yellow (B L 1); the dorsal blotches are a rich reddish-brown (8 L 7) outlined with sulfur yellow (10 J 1). In the dorsal blotch areas the scale bosses are a brighter reddish-brown (5 L 8). The lateral blotches, head markings, and paravertebral stripes are reddish-brown like the dorsal blotches. The dorsal pattern is very sharp except on the posterior fifth of the body, where there is a grayish suffusion which becomes more intense posteriad; the tail is grayish-black above. The ventrals are white, vaguely clouded and stippled laterally with yellow, orange-yellow, and grayish-purple. The specimen is clearly referable to *Crotalus durissus tzabcan,* not *C. d. durissus*.

This snake was caught on the crest of a ridge which was visible from Augustine. The altitude was probably around 2000 feet. The Mountain

Pine Ridge country presents a park-like aspect, with a ground cover of thick grasses beneath scattered pines, and with very little other conspicuous vegetation except along the rocky stream beds. (Dr. Albert M. Laessle, of the Department of Biology, University of Florida, has suggested the name "pine parkland" for this association.)

Various residents of British Honduras stated that rattlesnakes did not occur in the southern part of the country. This is probably correct. In British Honduras the mean annual rainfall increases markedly toward the south; it reaches about 150 inches at Punta Gorda, as contrasted with only 48 inches at Corozal in the north. *Crotalus durissus* is generally lacking from areas of high rainfall and dense forest.

Chelonia mydas mydas (Linnaeus). Schmidt (*op. cit.*) did not include any of the sea turtles in his British Honduras checklist. There is now considerable interest in the biology of these reptiles. Off the British Honduras coast, extending almost the full length of the country, is a triple line of islands and reefs, with a total area of about 267 square miles (Anderson, 1958: 1, 7). The islands, many with white sand beaches, should provide important nesting grounds for some of the species of marine turtles. Specific records are not easily come by, however. British Honduras has had a turtle fishery of minor economic importance, the reptiles being taken by net, by spear, or by overturning on the beaches (Fiedler *et al.*, 1943; Ingle and Smith, 1949: 58; Thompson, 1946). The Atlantic green turtle is among the species so taken.

Caretta caretta caretta (Linnaeus). As in many other areas, the Atlantic loggerhead is the most commonly encountered of the sea turtles, and figures the most prominently in the British Honduras fishery.

Eretmochelys imbricata imbricata (Linnaeus). The Atlantic hawksbill turtle is the third and last of the species reported to be involved in the British Honduras turtle fishery. The country once exported a good bit of "tortoise-shell" (Anderson, *op. cit.*: 63; Ingle and Smith, *loc. cit.*).

The Atlantic ridley, *Lepidochelys olivacea kempi* (Garman), has been reported from Isla de Mujeres off the coast of Quintana Roo (Smith and Taylor, 1950: 15), and so might reach British Honduras; but it is essentially a species of more northern waters, so far as is known, and should for the present be omitted from the British Honduras list. The Atlantic leatherneck, *Dermochelys coriacea coriacea* (Linnaeus), is to be expected from British Honduras waters, but specific records are lacking.

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RESEARCH DIVISION, ROSS ALLEN'S REPTILE INSTITUTE, INC., SILVER SPRINGS, FLORIDA

AN ATYPICAL *EURYCEA LUCIFUGA* FROM KANSAS.—On May 10, 1958, I collected a *Eurycea lucifuga* Rafinesque that had a color-pattern of typical spots on the tail, but had large, black, interconnected blotches on the dorsum (Fig. 1). It was caught in the twilight zone of a cave in Cherokee Co., Kan. Reese and Smith (1951, Copeia: 243-244, Fig. 1) described a similarly colored *E. lucifuga* from a cave 2 mi. N Flint, Delaware Co., Okla. Reese and Smith interpreted this aberration as "neoteny of pattern development." They also noted two specimens reported by Eigenmann and Kennedy, (1903, Biol. Bull.: 227-230, Fig. 1) from Marble and Rockhouse caves in Missouri (Stone and Barry counties, respectively), that exhibited this type of coloration on the sides of the body, but were normal on the dorsum and tail.

In life, my specimen lacked the typical orange pigment, with the exception of three small, irregular blotches of orange on the back. The predominant color was white.

It is interesting that all the specimens discussed here are from the same general area, all four collection-sites can be included in a circle 75 miles in diameter on the western periphery of the Ozark Plateau Region.

I thank John M. Legler, Curator of Herpetology, Univ. Kan. Mus. Nat. Hist., for allowing me to report on the Kansas specimen (KU 48589).—*W. L. Minckley, Contribution No. 24 (New Series) Dept. Biology, Univ. Louisville, Ky.*

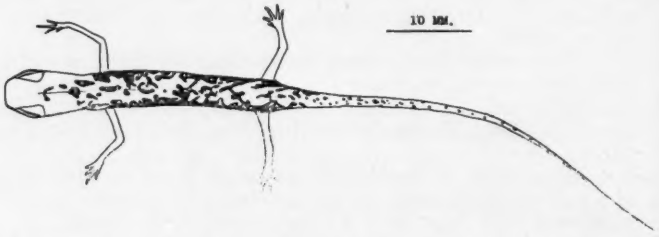

Fig. 1. An atypical color-pattern in *Eurycea lucifuga,* KU 48589, from Kansas (leg-coloration is omitted in the figure).

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PETE S. CHRAPLIWY

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